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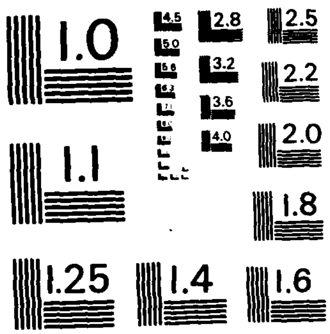

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DRAFT SUPPLEMENT

FINAL ENVIRONMENTAL IMPACT STATEMENT

FLOOD CONTROL

TWIN VALLEY LAKE

WILD RICE RIVER

NORMAN COUNTY

MINNESOTA

PART ONE: FISH AND WILDLIFE COMPENSATION PLAN

PART TWO: WATER QUALITY EVALUATION

PART THREE: SECTION 404(b)(1) EVALUATION

U.S. ARMY ENGINEER DISTRICT, ST. PAUL
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This document supplements the Final Environmental Impact Statement for the Twin Valley Lake-Wild Rive River Flood Control Project. Additional information is provided on proposed fish and wildlife compensation measures to offset project-induced losses, the results of water quality studies conducted by the U.S. Army Corps of Engineers, Waterways Experiment Station, and a Section 404 evaluation.

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GENERAL INTRODUCTION

This document supplements the Final Environmental Impact Statement (FEIS) for the Twin Valley Lake-Wild Rice River Flood Control Project, Norman County, Minnesota, which was filed with the Council on Environmental Quality on 7 October 1977. The FEIS presents a detailed discussion of impacts of the proposed project; a limited number of copies are available at the St. Paul District, Corps of Engineers, for those who may have a particular need for one. This supplement provides additional information on proposed fish and wildlife compensation measures to offset project-induced losses (Part One), the results of water quality studies conducted by the U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi (Part Two), and a Section 404(b)(1) evaluation (Part Three). Because these three parts are specialized reports that serve, in effect, as informational appendices to the earlier FEIS, they are not presented in standard EIS format. This information is being released as a supplement rather than as a supplemental information report due to the length and complexity of this information. The St. Paul District, Corps of Engineers, believes that the more extensive draft and final review process required for an EIS supplement will render this information more useful to concerned agencies and the public.

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PART ONE:

FISH AND WILDLIFE COMPENSATION PLAN

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I. INTRODUCTION

A. General

The purpose of this part of the supplement to the FEIS is to discuss the general process and supporting background documents which serve as the basis for the Fish and Wildlife Compensation Plan for the proposed Twin Valley Lake Project, Norman County, Minnesota.

This report represents the culmination of an extensive analysis of the environmental impacts and habitat losses and gains which would result from the proposed project. The analysis was conducted in accordance with the Habitat Evaluation Procedures (HEP) developed by the U.S. Fish and Wildlife Service (FWS) and generally agreed upon in concept by the U.S. Army Corps of Engineers (COE), and Minnesota Department of Natural Resources (MDNR). The analysis was conducted by a tri-agency team of fish (aquatic) and wildlife (terrestrial) biologists representing the COE, FWS, and MDNR. The field investigation began in May, 1976, as a result of a mutual agreement between the three agencies to determine fish and wildlife impacts expected to result from the proposed project. A user-day (monetary) evaluation was also conducted and is included in this report (Section V).

The HEP procedures provide a uniform, nationwide method for determining impacts on fish and wildlife and their habitat arising from water development projects. These procedures satisfy certain mandates. First, the Fish and Wildlife Coordination Act assumes the existence of an evaluation procedure. Second, the National Environmental Policy Act (NEPA) requires that:

> "...all agencies of the Federal Government shall (a) utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision-making which may have an impact in man's environment; (b) identify and develop methods and procedures in consultation with the Council on Environmental Quality established by Title II of this Act, which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations..."

Third, the Principles and Standards for Planning Water and Related Land Resources, which were developed in response to the 1965 Water Resources Planning Act, require that:

> "...Plans for the use of the Nation's water and land resources will be directed to improvement in the quality of life through contributions to the objectives of national economic development

and environmental quality. The beneficial and adverse effects on each of these objectives will be displayed in separate accounts... Planning for the use of water and land resources in terms of these objectives will aid in identifying alternative courses of action and will provide the type of information needed to improve the public decision-making process..."

B. Project Background

The proposed project includes the construction of an earth-fill dam across the Wild Rice River upstream from Twin Valley, Minnesota (refer to Figures 1 and 2). The proposed project would convert a 7-mile reach of the Wild Rice River from a free-flowing stream to a reservoir-type environment. A permanent recreation and silt storage pool of about 540 acres would be created. An additional 1,100 acres of flood pool would be allocated for floodwater storage. The total project area acquired in fee would be approximately 3,500 acres. Additional information regarding the project features can be found in the Final EIS dated February 1975 and Design Memorandum No. 2 (Phase I) dated February 1975.

C. Major Environmental Changes

The Wild Rice River Valley contains a diverse assemblage of mixed hardwood forest surrounded by a predominantly agricultural area. The proposed project would initially convert 540 acres of riparian habitat to a reservoir-type environment. An additional 1,100 acres of riparian and upland habitat in the flood pool would be converted to an open grass-shrub environment.

With construction of Twin Valley Reservoir, the downstream reaches would no longer experience frequent inundation due to flooding. The riparian habitat along the river would gradually show a shift from flood-tolerant species to vegetation normally found in drier areas.

The existing river would be converted from a shallow, rapidly flowing waterway to a standing water lake. A permanent loss of the present bottom and streamside ecosystem would result.

Animal populations currently inhabiting the project area would either migrate to unaffected areas (i.e., either upstream and downstream of the reservoir or beyond the valley) or would be eliminated. Some of the wildlife species which would be affected include deer, beaver, mink, ruffed grouse, squirrel, raccoon, fox, and an abundance and variety of birds. Other wildlife species (e.g., herons, pelicans, shorebirds, bank nesting birds, and a variety of ducks) would migrate into the area to inhabit the environs which would be vacated and/or developed through the formation of the reservoir.

Additional information regarding project-associated modification of habitats can be found in the Final Environmental Impact Statement (February 1975). (A limited number of copies are still available from the St. Paul District, Corps of Engineers, 1135 U.S. Post Office and Custom House, St. Paul, Minnesota 55101, upon request.)

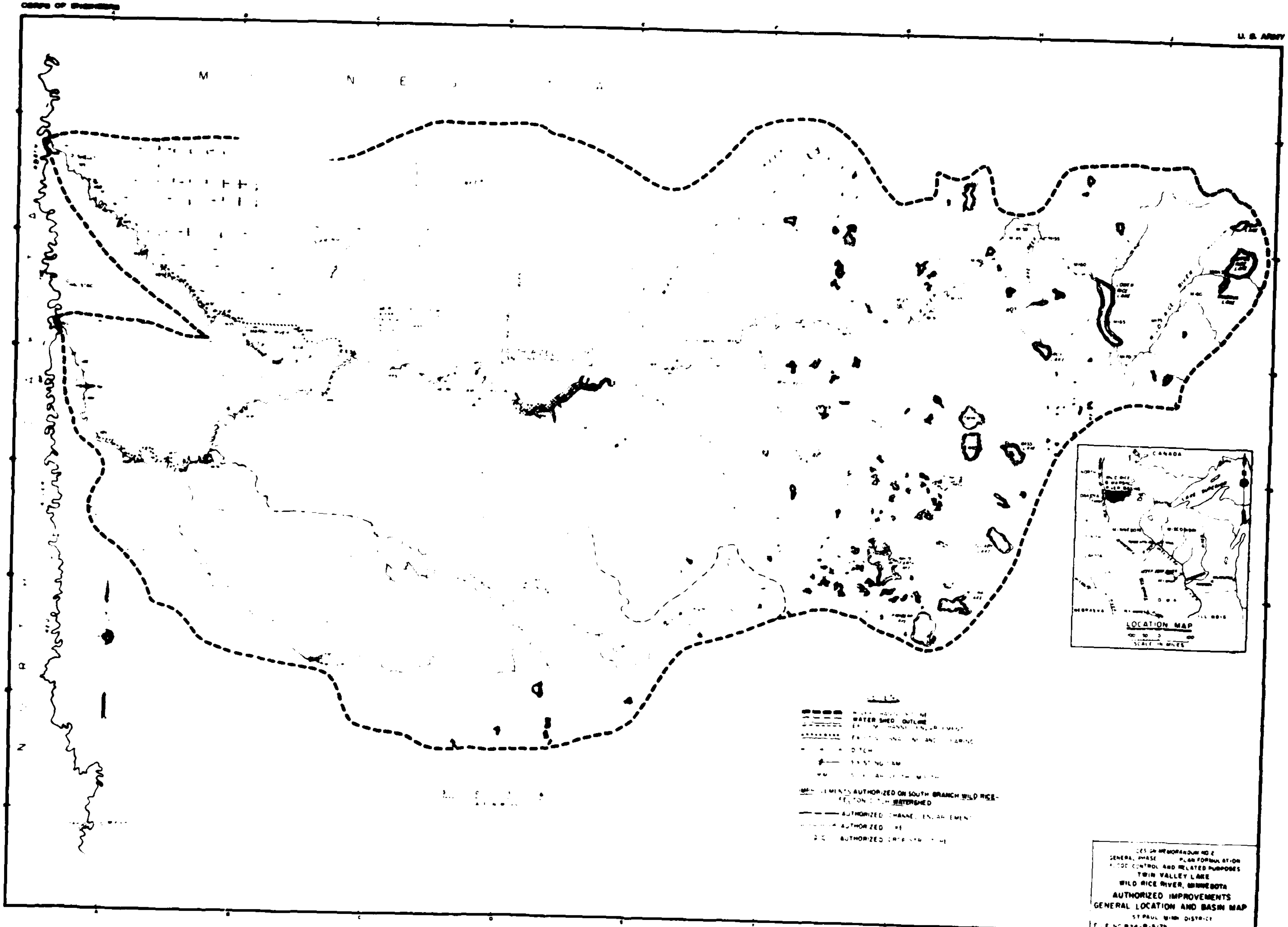
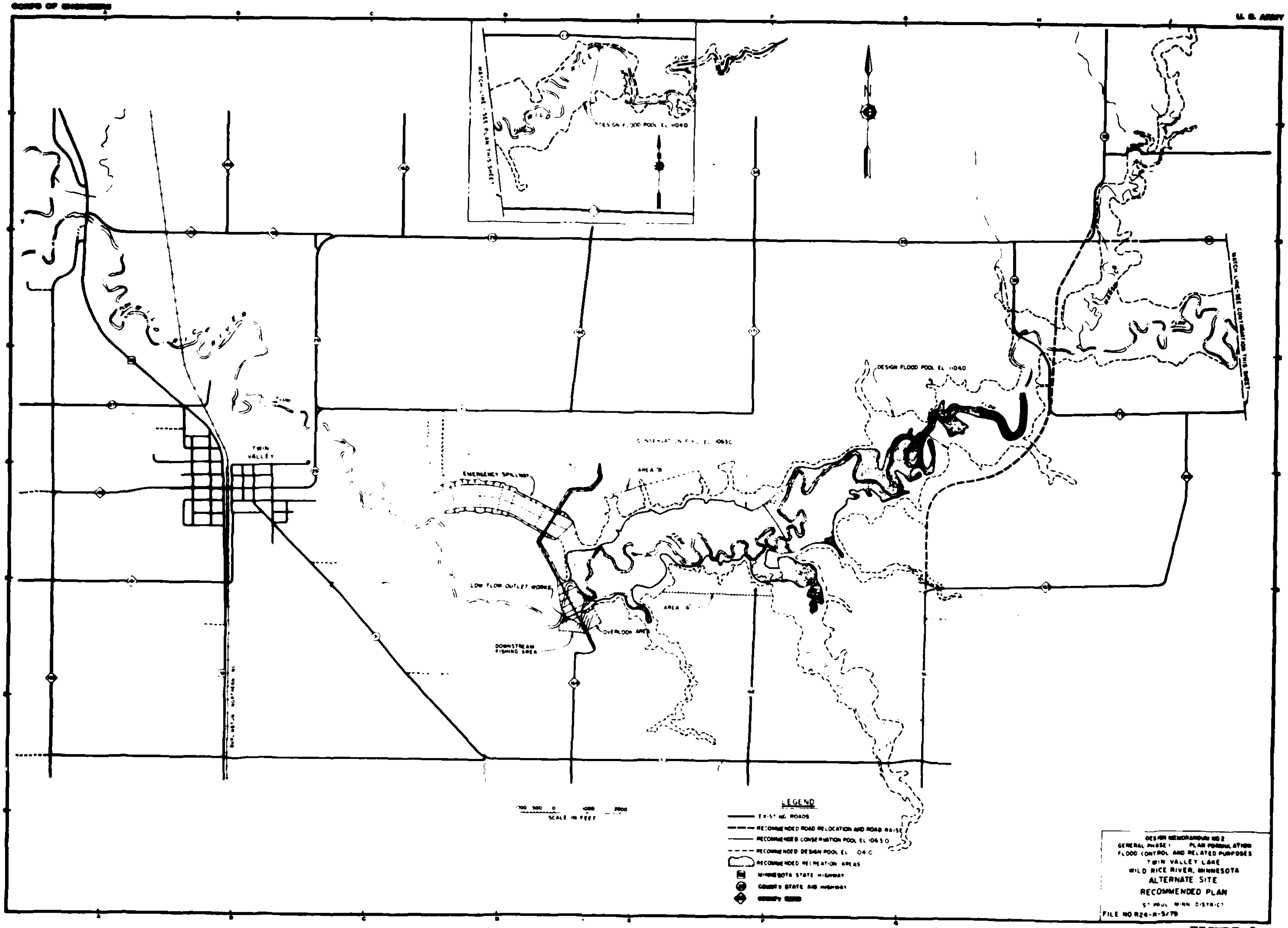

CORPS OF ENGINEERS
U. S. ARMY
CANADA
LOCATION MAP
SCALE IN MILES
WATER SHED OUTLINE
AUTHORIZED ON SOUTH BRANCH WILD RICE-
WATERSHED
AUTHORIZED CHANNEL
AUTHORIZED
AUTHORIZED
TWIN VALLEY LAKE
WILD RICE RIVER, MINNESOTA
AUTHORIZED IMPROVEMENTS
GENERAL LOCATION AND BASIN MAP

FIGURE 1



CORPS OF ENGINEERS
U. S. ARMY
TWIN VALLEY
DESIGN FLOOD POOL EL 1104.0
CONSERVATION POOL EL 1063.0
EMERGENCY SPILLWAY
AREA 'B'
AREA 'A'
LOW FLOW OUTLET WORKS
OVERLOOK AREA
DOWNSTREAM FISHING AREA
MATCH LINE - SEE PLAN THIS SHEET
MATCH LINE - SEE CONTINUATION THIS SHEET
N
SCALE IN FEET
LEGEND
EXISTING ROADS
RECOMMENDED ROAD RELOCATION AND ROAD RAISE
RECOMMENDED CONSERVATION POOL EL 1063.0
RECOMMENDED DESIGN POOL EL 1104.0
RECOMMENDED RECREATION AREAS
MINNESOTA STATE HIGHWAY
COUNTY STATE AID HIGHWAY
DESIGN MEMORANDUM NO 2
GENERAL PHASE I PLAN FORMULATION
FLOOD CONTROL AND RELATED PURPOSES
TWIN VALLEY LAKE
WILD RICE RIVER, MINNESOTA
ALTERNATE SITE
RECOMMENDED PLAN
ST PAUL, MINN DISTRICT
FILE NO R24-R-5/79

FIGURE 2

II. HABITAT EVALUATION PROCEDURES

A. Methodology

The Habitat Evaluation Procedures (HEP) consist of both a non-monetary and monetary evaluation. The non-monetary evaluation measures the quality of the habitat in the area, taking into consideration the full range of fish and wildlife present. Habitat changes were determined for both the "future with project" and "future without project" conditions. The HEP equated the value of different habitats in the form of a common denominator called the "habitat unit." The habitat changes expected to result from the project were calculated to determine gains and losses. The compensation needs were then determined by comparing the difference in habitat units lost to those that would be gained.

The first step in the Habitat Evaluation Procedures was to determine the base or present condition. To accomplish this step, a variety of maps and aerial photos were obtained and utilized by the tri-agency team to delineate the various habitat types present in the project area. From these areas, a number of sample sites were then selected to represent the different habitat types. Due to the complexity of the Twin Valley analysis, the tri-agency team decided that both site and interspersion evaluations would be accomplished in the field.

After the selection of sample sites, the tri-agency team made an evaluation of the capability of the habitat at each site to meet the requirements (reproductive, protective cover, food sources, etc.) of a given number of wildlife species. The habitat type was rated on a scale of 1 to 10 according to its ability to provide the life requirements for each animal selected. The sample site value was the total score for all species evaluated, and the average of all sample site values represented the habitat unit (HU) value for each habitat type in question. By multiplying the habitat unit value by the number of acres of each habitat type, the total number of habitat units for each habitat type was determined. These data were then used to determine both the future with project and future without project conditions. A computer program was utilized to evaluate the factors and assumptions required to determine net habitat changes over the life (100 years) of the project.

The without project condition (base or present condition) was determined through the use of aerial photographs, terrestrial maps, and field work to verify the collected information. Some assumptions were made based on past and current trends to predict what changes might occur in the project area. In this and other extrapolations, fish and wildlife habitat and production were evaluated over time and not just for the beginning and ending conditions.

The future with project conditions were computed by analyzing each of the characteristics being studied, such as human use, fish and wildlife habitat, and production, etc., for a series of target years through the 100-year life of the project. The results of this analysis provided either the beneficial or adverse impacts for each habitat type.

A comparison of conclusions reached from the information in the preceding two paragraphs indicated the relative fish and wildlife impacts and provided a basis for determining the mitigation needs of the project. The purpose of this evaluation was to determine ways in which the project could be modified to minimize adverse impacts. The final step then involved deriving a comprehensive plan which would compensate, to the fullest extent possible, for the losses of significant fish and wildlife resources. In this analysis, the scarce or significant resources under evaluation included both the various habitat types in the river valley area and the wildlife species that these habitat types support (refer to the FEIS, paragraphs 2.61 to 2.135, for a discussion of the existing terrestrial and aquatic resources in the project area). The Wild Rice River Valley at Twin Valley, Minnesota, is a finger-like projection of the eastern and central deciduous forests into a predominantly agricultural area (i.e., 93 percent of all land in Norman County is agricultural). As a result, many of the plant and animal species that would not normally occur in a highly agricultural area can be found within the proposed reservoir takeline. Specifically, the river valley area provides excellent wintering habitat for the white-tailed deer and ruffed grouse, while the river provides spring spawning areas for northern pike.

Every effort was made to "replace habitat losses in-kind." However, other habitat types had to be considered due to the extent of riparian habitat lost, lack of similar replacement habitat in sufficient quantity in the vicinity of the project area, and inability of the remaining riparian habitat to provide adequate compensation.

The monetary segment of the evaluation provided data on supply and demand for fish and wildlife in the project area. It also furnished some of the benefit and cost figures for allocating project costs among project purposes. The methodology is described in the U.S. Fish and Wildlife Service's HEP guidelines. The detailed results of utilizing this methodology are displayed in this report. The monetary evaluation (Section V). does not indicate the full extent of fish and wildlife resource losses, and alone cannot be utilized to adequately determine fish and wildlife compensation needs. The monetary evaluation, however, does provide a detailed analysis of selected fish and wildlife resources and their supply and demand which was utilized in the preparation of the Fish and Wildlife Compensation Plan.

The Fish and Wildlife Compensation Plan provides, to the fullest extent possible, detailed recommendations. However, many recommendations, such as those requiring structures, may require additional engineering specification. These features should be further evaluated and possibly modified in future design memorandums.

B. Terrestrial Evaluation

1. Terrestrial Habitat Inventory

a. Field Notes

Most of the terrestrial field surveys were conducted by the tri-agency team during the period June 29 - August 11, 1976. During this period, for each survey between two and four fish and wildlife biologists photographed the project area and collected the basic data for the HEP process.

The field notes and record of photographs were not always complete, however, because the team of biologists often evaluated habitat conditions on-the-spot and recorded the results on a variety of field forms (HEP forms, notebooks, etc.).

b. Summary

From the field notes, aerial photography (black and white, and color infra-red) and U.S.G.S. quadrangle maps, existing terrestrial habitat maps were prepared for the project area. These maps can be obtained from the St. Paul District, Corps of Engineers, 1135 U.S. Post Office and Custom House, St. Paul, Minnesota 55101, or the U.S. Fish and Wildlife Service, Federal Building, Fort Snelling, Twin Cities, Minnesota 55111.

Although infra-red aerial photographs did not accurately define the differences between such habitat types as upland and lowland hardwoods, upland and lowland brush, and certain types of cropland, this problem was overcome by ground truthing those areas where uncertainty of habitat types existed. The tri-agency team felt that if the aerial photographs could have been taken at a different time (i.e., during different periods of the growing season) a more accurate demarcation of habitat typing could have been made. However, the best possible job was done with the existing aerial photographs aided by field observations.

Table 1 shows the results of the terrestrial habitat inventory for the project area.

2. Wildlife Species Evaluation Criteria

Wildlife Species Evaluation Criteria were developed for all of the selected wildlife species in order to rate each terrestrial habitat type in the project area, based on a numerical rating of 1 to 10, with 10 representing the highest existing value. These criteria were needed to provide the "best" possible background data for a subjective analysis and completion of HEP form 3-1101 (Fish and Wildlife Habitat Field Evaluation Sheet) by the tri-agency team.

The Wildlife Species Criteria were utilized to determine the value of a particular terrestrial habitat to a broad group of selected wildlife species (evaluated independently of each other) representative of that habitat type in the project area. Where several similar habitat types existed, each habitat type was rated independently. Other considerations, such as the comparison of one habitat type (upland hardwoods) to another habitat type (upland brush) were not considered here.

TABLE 1 EXISTING TERRESTRIAL HABITAT CONDITIONS - PROJECT AREA

Habitat	Conservation Pool	Lower Floodpool	Upper Floodpool	Take Line	Recreation Area A	Recreation Area B	Spillway/ Structures	Total Acres
Upland Hardwood	-----	75.0	208.9	517.4	2.6	43.9	83.9	931.7
Lowland Hardwood	331.6	301.6	281.4	103.9	----	----	19.8	1,038.3
Oxbows	25.8	0.9	10.5	8.0	----	----	----	45.2
Upland Brush	-----	1.0	13.5	27.7	0.9	----	0.9	44.0
Lowland Brush	39.9	18.0	4.1	2.3	----	----	----	64.3
Grassland	16.8	36.1	54.2	101.0	6.0	----	2.9	217.0
Cropland	45.1	22.2	22.2	478.4	33.0	2.3	15.3	618.5
Streambank	78.5	57.0	35.6	10.0	----	----	3.1	184.2
Type 6 Wetland	-----	4.1	3.9	-----	----	----	----	8.0
TOTAL ACRES	537.7	515.9	634.3	1,248.7	42.5	46.2	125.9	3,151.2

3. Terrestrial Habitat Evaluation

The project area was divided into the following planning segments for HEP purposes:

Flood Pool
  Elevation 1063-1085 M.S.L.
  Elevation 1085-1104 M.S.L.
Conservation (permanent) Pool
Take Line (additional project related lands)
Recreation Area A
Recreation Area B
Spillway/Structures

The HEP evaluations were computed both manually and by computer. The manual analysis does not exactly agree with the computer printout results because the computer rounded off the numbers to a greater degree, eliminated human mathematical errors, and often recorded the data differently than the hand calculations. The computer results are, however, more accurate and represent the accepted results of the HEP process. Table 2 summarizes the initial terrestrial habitat compensation requirements resulting from losses in the project area.

4. Other Terrestrial Habitat Investigations

a. General

The tri-agency team conducted a number of additional investigations to ensure the adequacy of the overall habitat evaluation. Although the results of these evaluations were not directly utilized in the compensation calculations, they did influence evaluation assumptions and generally supported the conclusions.

b. Environmental Effects Below Twin Valley Lake

Table 3 lists the environmental effects of the proposed Twin Valley Lake on the area downstream of the dam. (This table is intended to respond to the Citizens Committee's concerns that the interagency habitat evaluation team properly consider beneficial environmental impacts downstream of the proposed dam.) The effects are compared with existing conditions to allow consideration of corresponding positive and negative effects for the different environmental line items. Only direct effects applicable to the reservoir-stream situation of appreciable magnitude are listed. Conditions would be somewhat different in other reservoir-stream situations.

Overall, the Twin Valley Lake project is expected to have a neutral environmental effect in the Downstream area, all factors considered. However, due to the many uncertainties which presently exist when a floodplain no longer experiences inundation, the overall changes to this type of environment cannot be foreseen until some time in the future; hence, a potential for substantial adverse effects may still exist. Nevertheless, given limited study time which would have to be applied to a rather complex problem (all downstream effects) and given the much greater impacts in the pool area (many of which go well beyond the adaptations and/or resiliency of the ecologic systems), study attention was directed to the reservoir area.

TABLE 2

TERRESTRIAL HABITAT LOSSES IN PROJECT AREAS

Habitat Type	Existing Area (acres)[1]	Annualized HU Change[1) 2)]
Upland Hardwoods	931.7	18,876.4
Lowland Hardwoods	1,038.3	-25,009.3
Oxbows	45.2	- 1,422.8
Upland Brush	44.0	17,606.3
Lowland Brush	64.3	1,704.1
Grassland	217.0	210.7
Cropland	618.5	-29,126.3
Streambank	184.2	- 5,106.7
Type 6 Wetland	8.0	- 43.6
	3,151.2 [3]	-22,311.2[4]

1) Data taken from HEP Forms 3-1103, 1104, and 1106.
2) Negative values represent losses which have occurred on project lands and positive values represent successional gains on project lands following acquisition (based on a 100-year period of analysis).
3) Existing acres on project land.
4) Annualized HU's lost on project land.

TABLE 3 DOWNSTREAM IMPACTS OF TWIN VALLEY LAKE

Positive	Negative
1. Less bank undercutting and channel shifting during high flows. Limited water quality benefits because stream is fairly turbid at that time. Less toppling of streambank vegetation.	1. Fewer snags available as habitat for aquatic organisms and semi-aquatic wildlife.
2. Less ice debarking of streambank trees and less breakage or pushing over of small trees and brush.	2. No corresponding debit.
3. Increased stands of floodplain understory vegetation because floods no longer kill or select against it (more profuse growth of some species such as prickly ash and wood nettle would be a debit, however).	3. Reduced growth rates of trees below the dam. Tree species composition shift toward drier site species below dam is considered negative because it reduces overall diversity in the area.
4. Theoretically, more erosive low flows remove channel sediment giving minor benefit to aquatic organisms.	4. Theoretically, greater channel erosion during low flows.
5. Less flooding of bird nests, small mammal nests, etc.	5. No corresponding debit. Renesting offsets to a degree.
6. Less chasing of mobile wildlife from floodplain during floods.	6. No corresponding debit.
7. No corresponding benefit.	7. Less long-term productivity of floodplain vegetation due to less periodic perturbation compatible in degree and type which stimulates the habitat type.
8. No corresponding benefit.	8. Any induced more intensive land use and development reduces habitat quality and quantity.
9. No corresponding benefit.	9. Blockage of upstream and downstream movement, especially for aquatic forms.
10. Improved water quality for some parameters, such as less turbidity during operation.*	10. Degraded water quality for some parameters such as increased hydrogen sulfide levels during operation and more turbidity during construction.*

*Refer to Part Two of this supplement for a discussion of the potential water quality in the proposed reservoir. Also see Design Memorandum No. 4, Water Quality, dated January 1980.

5. Flood Damage/Frequency Analysis

A flood damage/frequency analysis, based on a mathematical-graphical approach, was developed to describe potential vegetational flood damages within the floodpool area of the proposed Twin Valley Reservoir. The resulting estimates were derived from all-season hydrographs and damage curves.

The damage/frequency analysis is based on the methodology described in the report: "Corps of Engineers, February 1977, Assessment of Habitat Damages Due to Flooding: A Proposed Methodology." The information presented in the following tables for the Twin Valley Project follow the format described in that report.

There are some parameters which have to be developed for each specific project. The damage-duration curves presented in Figures 3 and 4 were developed for this analysis. They are based on extensive literature review, personal experience, and communications with other scientists and researchers. The curves show the percent loss of Habitat Units based on the duration of flooding. The average annual loss (Table 4) by habitat type using exceedence frequency is calculated based on the damage-duration curves.

Table 4 shows the average annual equivalent loss at various target years. While Table 5 shows the average annual equivalent losses for different flood frequencies, these calculations take into consideration an annual recovery factor. For example, an annual recovery factor of 2 percent means that 100 percent recovery will occur in 50 years. This assumes a linear relationship. In both Tables 4 and 5 the "difference" and "X" columns are used to calculate the area under the curve, or the average annual value, when the data are plotted on a graph. To facilitate the manual calculation of the Average Annual Equivalent changes without resorting to a lengthy iterative process, the following expression was developed:

$$HU_t = \left(x^{t+1}\right) Ho + \frac{y(1-x^t)}{1-x} + yx^t$$

where: HU = habitat units remaining at the end of year "t".

Ho = total habitat units subjected to damage at start of project.

t = time in year.

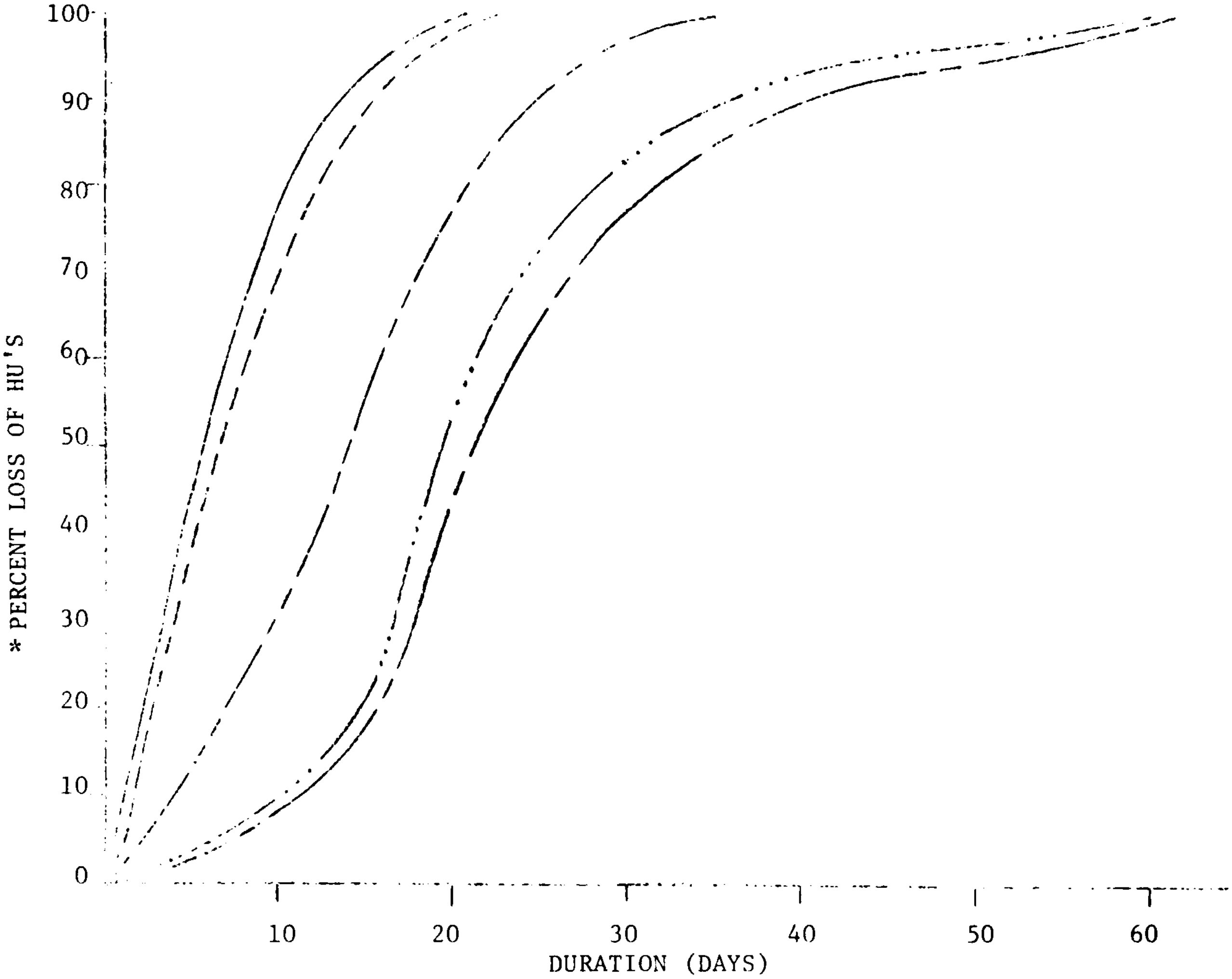
$$x = \left(1 - \frac{\text{Avg. annual loss in \%}}{100}\right)\left(1 - \frac{\text{Avg. recovery in \%}}{100}\right)$$

$$y = \left(1 - \frac{\text{Avg. annual loss in \%}}{100}\right) Ho \left(\frac{\text{Avg. recovery in \%}}{100}\right)$$

Using this formula, the expression $\frac{y}{1-x}$ equals the limit of HU_t as the annual recovery and annual loss approach each other. In application, only the number of points necessary to define the curve need be calculated, simplifying the calculation of the Average Annual Equivalent value by a considerable amount. This analysis is also readily suitable for computerization.

The flood/damage frequency analysis, summarized in Table 6, is useful as another method for evaluating or comparing vegetational flood damages. However, this analysis cannot be directly compared with the Natural/Project-Induced Succession Analysis discussed previously since it applies to the floodpool only. The Natural/Project-Induced Succession Analysis was applied to the entire project area which also included the area between the floodpool line and the project takeline.

TWIN VALLEY DAMAGE CURVES (RESERVOIR)



Upland brush -greater loss due to a shorter height of vegetation

Upland hardwoods

Grassland

Lowland hardwoods

Lowland brush -less loss due to the type of species present. These species are generally more water-tolerant.

*The value of the loss levels off at about 95 percent, because even the mudflats have some value. However, the curve goes to 100 percent which makes it easier to perform mathematical calculations later on.

FIGURE 3

TWIN VALLEY DAMAGE CURVES

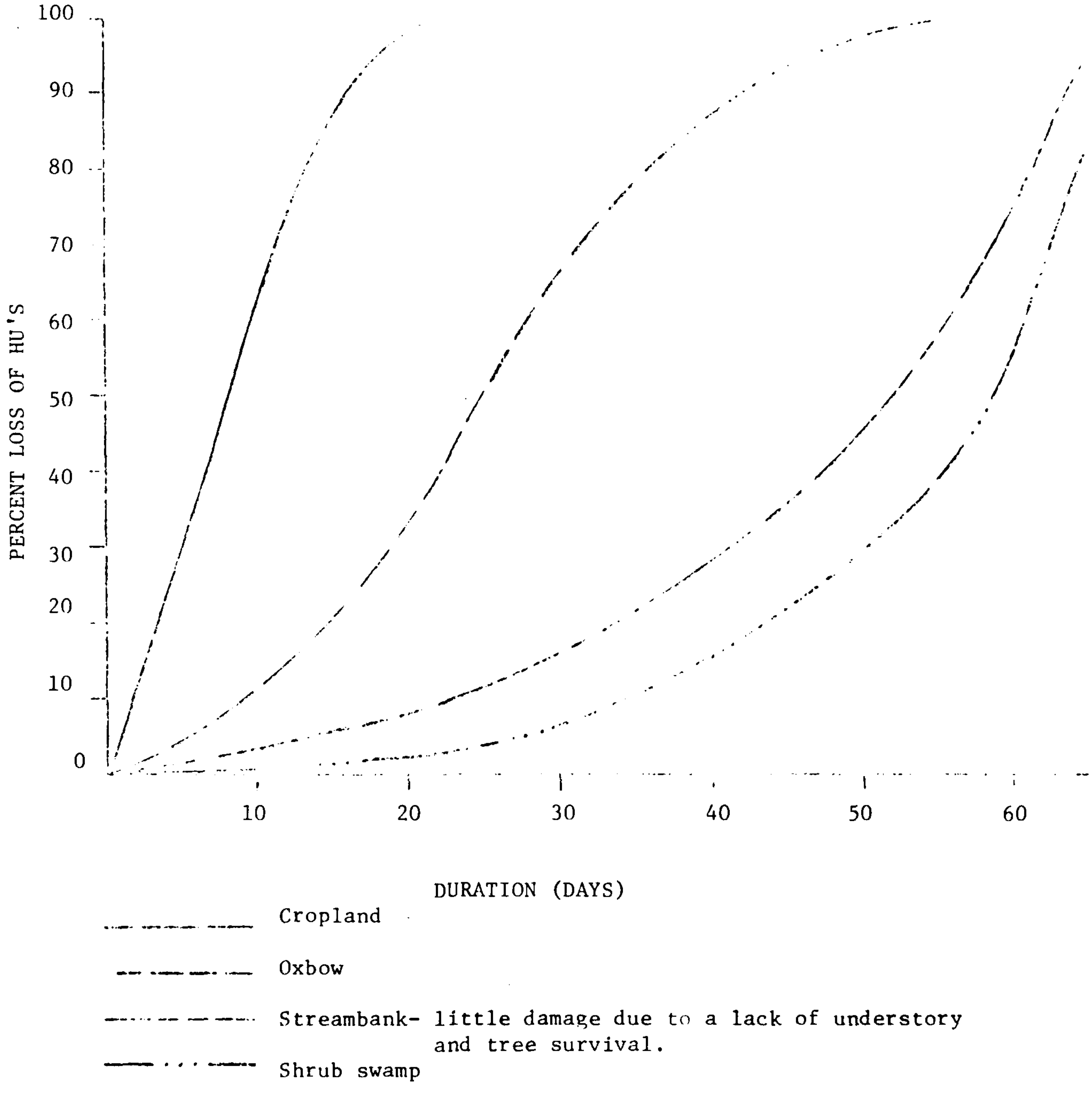


FIGURE 4

TABLE 4

AVERAGE ANNUAL EQUIVALENT LOSSES AT VARIOUS TARGET YEARS

Twin Valley - Upland Hardwood (Flood Pool) (17,488.1)

Avg. Annual Loss = 4.17% Annual Recovery = 1.3%

Year	H.U.	Diff.	X's
0	16,758.8	- 729.3	200
10	11,321.1	- 5,437.7	195
20	8,205.0	- 3,116.1	185
40	5,396.1	- 2,808.9	170
80	4,170.9	- 1,225.2	140
120	4,038.7	- 132.2	100
200	4,023.0	- 15.7	40

X = .9458421
Y = 217.865001
min = 4022.8

Avg. Ann. Equiv. = -12,227.9 H.U.'s
Avg. Annual = -729.5 H.U.'s

Lowland Hardwood (34,224.2)

Avg. Annual Loss = -4.73% Annual Recovery = 2.0%

Year	H.U.	Diff.	X's
0	32,605.4	- 1,618.8	200
10	21,291.6	-11,313.8	195
20	15,597.4	- 5,694.2	185
40	11,289.2	- 4,308.2	170
80	9,921.5	- 1,367.7	140
120	9,833.7	- 87.8	100
200	9,827.7	- 6.0	80

X = .933646
Y = 652.1079068
min = 9,827.7

Avg. Ann. Equiv. = -22,582.6 H.U.'s
Avg. Annual = -1,617.8 H.U.'s

TABLE 4 (Cont.)

Oxbows (587.3)

Avg. Annual Loss = -2.42%

Annual Recovery = 10%

Year	H.U.	Diff.	X's
0	573.1	- 14.2	200
5	524.1	- 49.0	197.5
10	498.6	- 25.2	192.5
20	478.2	- 20.4	185
40	471.2	- 7.0	170
60	470.6	- 0.6	150

X = .87822
Y = 57.308734
min = 470.6

Avg. Ann. Equiv. = -112.1 H.U.'s
Avg. Annual = -14.2 H.U.'s

Upland Brush (950.0)

Avg. Annual Loss = -3.41%

Annual Recovery = 10%

Year	H.U.	Diff.	X's
0	917.60	- 32.4	200
5	809.1	-108.5	197.5
10	755.2	- 53.9	192.5
20	715.2	- 40.0	185
40	702.9	- 12.3	170
65	702.1	- 0.8	147.5

X = .86931
Y = 91.7605
min = 702.1

Avg. Ann. Equiv. = -239.5 H.U.'s
Avg. Annual = -32.4 H.U.'s

Lowland Brush (1414.4)

Avg. Annual Loss = -5.48%

Annual Recovery = 20%

Year	H.U.	Diff.	X's
0	1,336.9	- 77.5	200
5	1,156.0	-180.9	197.5
10	1,111.2	- 44.8	192.5
15	1,100.2	- 11.0	187.5
20	1,097.4	- 2.8	182.5
35	1,096.5	- 0.9	172.5

X = .75616
Y = 267.378176
min = 1096.5

Avg. Ann. Equiv. = -312.9 H.U.'s
Avg. Annual = -77.4 H.U.'s

TABLE 4 (Cont.)

Grassland (5098.1)

Avg. Annual Loss = -4.24%

Annual Recovery = 5.

Year	H.U.	Diff.	X's
0	4,881.9	-216.2	200
5	4,060.9	-821.0	197.5
10	3,549.4	-511.5	192.5
20	3,032.0	-517.4	185
40	2,753.2	-278.8	170
80	2,704.9	- 48.3	140
110	2,703.8	- 1.1	105

X = .90972
Y = 244.097028
min = 2703.8

Avg. Ann. Equiv. = -2,269.2 H.U.'s
Avg. Annual = -216.2 H.U.'s

Cropland (2130.3)

Avg. Annual Loss = 8.20%

Annual Recovery = 50%

Year	H.U.	Diff.	X's
0	1,955.6	-174.7	200
2	1,838.6	-117.0	199
5	1,810.4	- 28.2	196.5
10	1,807.5	- 2.9	192.5
15	1,807.4	- 0.1	187.5

X = .459
Y = 977.8077
min = 1807.4

Avg. Ann. Equiv. = -321.7 H.U.'s
Avg. Annual = -174.7 H.U.'s

Streambank (5574.6)

Avg. Annual Loss = 1.50%

Annual Recovery = 2.5%

Year	H.U.	Diff.	X's
0	5,491.0	- 83.6	200
10	4,817.0	-674.0	195
20	4,367.1	-499.9	185
40	3,866.5	-500.6	170
80	3,544.1	-322.4	140
120	3,480.2	- 63.9	100
200	3,465.0	- 15.2	40

X = .960375
Y = 137.274525
min = 3464.3

Avg. Ann. Equiv. = -1,843.1 H.U.'s
Avg. Annual = -83.7 H.U.'s

TABLE 4 (Cont.)

Shrub Swamp (580.1)

Avg. Annual Loss = 0.84%

Annual Recovery = 5.0%

Year	H.U.	Diff.	X's
0	575.2	- 4.9	200
10	539.6	- 35.6	195
20	520.0	- 19.6	185
40	503.3	- 16.7	170
80	496.7	- 6.6	140
160	496.0	- 0.7	80

X = .94202
Y = 28.761358
min = 496.0

Avg. Ann. Equiv. = -76.8 H.U.'s
Avg. Annual = -4.9 H.U.'s

TABLE 5

AVERAGE ANNUAL EQUIVALENT LOSSES FOR DIFFERENT FLOOD FREQUENCIES

Upland Hardwood
(17,488.1 H.U.)

1.3% Recovery

% Flood	H.U. Lost	Diff.	X's
100.	0	0	1.00
20.	0	0	.60
10.	406.1	- 406.1	.15
05.	4,424.3	- 4,018.2	.075
02.	12,987.2	- 8,562.9	.035
01.	17,488.1	- 4,500.9	.015
00.5	17,488.1	0	.0075

$\overline{X}$ = -729.495
% = -4.17

Lowland Hardwood
(34,224.2 H.U.)

2% Recovery

% Flood	H.U. Lost	Diff.	X's
20.	0	0	.60
10.	1,771.9	- 1,771.9	.15
05.	11,003.2	- 9,231.3	.075
02.	28,323.5	-17,320.3	.035
01.	31,575.0	- 3,251.5	.015
00.5	32,201.4	- 626.4	.0075

$\overline{X}$ = -1,617.8135
% = -4.73

Oxbows
(587.3 H.U.)

10% Recovery

% Flood	H.U. Lost	Diff.	X's
20.	0	0	.60
10.	0	0	.15
05.	19.5	- 19.5	.075
02.	325.3	- 305.8	.035
01.	447.4	- 122.1	.015
00.5	475.5	- 28.1	.0075

$\overline{X}$ = -14.20775
% = -2.42

TABLE 5 (Cont.)

Upland Brush
(950.0 H.U.)

10 yr Recovery = 10%

% Flood	H.U. Lost	Diff.	X's
20.	0	0	.60
10.	0	0	.15
05.	64.0	- 64.0	.075
02.	778.1	- 714.1	.035
01.	950.0	- 171.9	.015
005	950.0	0	.0075

$\overline{X}$ = -32.372
% = -3.41

Lowland Brush
(1414.4 H.U.)

20% Recovery

% Flood	H.U. Lost	Diff.	X's
20.	0	0	.60
10.	84.0	- 84.0	.15
05.	662.7	- 578.7	.075
02.	1,240.7	- 578.0	.035
01.	1,311.3	- 70.6	.015
005	1,332.2	- 20.9	.0075

$\overline{X}$ = -77.44825
% = -5.48

Grassland
(5098.1 H.U.)

5% Recovery

% Flood	H.U. Lost	Diff.	X's
20.	0	0	.60
10.	91.1	- 91.1	.15
05.	1,326.6	- 1,235.5	.075
02.	4,072.1	- 2,745.5	.035
01.	4,955.9	- 883.8	.015
005	5,031.3	- 75.4	.0075

$\overline{X}$ = -216.2425
% = -4.24

TABLE 5 (Cont.)

Cropland
(2130.3 H.U.)

50% Recovery

% Flood	H.U. Lost	Diff.	X's
20.	0	0	.60
10.	850.9	- 850.9	.15
05.	1,068.9	- 218.0	.075
02.	1,807.9	- 739.0	.035
01.	2,130.3	- 322.4	.015
00.5	2,130.3	0	.0075

$\bar{X}$ = -174.686
% = 8.20

Streambank
(5574.6 H.U.)

2.5% Recovery

% Flood	H.U. Lost	Diff.	X's
20.	0	0	.60
10.	94.8	- 94.8	.15
05.	379.0	- 284.2	.075
02.	1,462.0	- 1,083.0	.035
01.	2,009.5	- 547.5	.015
00.5	2,280.7	- 271.2	.0075

$\bar{X}$ = -83.6865
% = -1.50

Shrub Swamp
(580.1 H.U.)

5% Recovery

% Flood	H.U. Lost	Diff.	X's
20.	0	0	.60
10.	3.4	- 3.4	.15
05.	15.7	- 12.3	.075
02.	90.8	- 75.1	.035
01.	137.1	- 46.3	.015
00.5	152.5	- 15.4	.0075

$\bar{X}$ = -4.871
% = 0.84

TABLE 6

SUMMARY: TWIN VALLEY SITE #2
PROJECT CONDITIONS-DAMAGE-FREQUENCY ANALYSIS

Habitat Type	Base H.U.	Avg. Ann. Loss (%)	Avg. Ann. Loss-H.U.	Annual Recovery (%)	Avg. Annual Equivalent loss
Upland Hdw.	17,488.1	4.17	729.3	1.3	12,227.9
Lowland Hdw.	34,224.2	4.73	1,617.8	2.0	22,582.6
Oxbows	587.3	2.42	14.2	10.0	112.1
Upland Brush	950.0	3.41	32.4	10.0	239.5
Lowland Brush	1,414.4	5.48	77.4	20.0	312.9
Grassland	5,098.1	4.24	216.2	5.0	2,269.2
Cropland	2,130.3	8.20	174.7	50.0	321.7
Streambank	5,574.6	1.50	83.7	2.5	1,843.1
Shrub Swamp	580.1	0.84	4.9	5.0	76.8

C. Aquatic Evaluation

1. General

The aquatic habitat evaluation takes into account the total loss of the stream under the dam and in the conservation (permanent) pool. Changes that would occur in the stream segments located in the floodpool and tailwater areas were also evaluated.

The adverse and beneficial impacts of the proposed reservoir fishery were not included in the evaluation process because they are considered concomitant to the primary project purpose of flood control. The reservoir fishery is not considered an enhancement because the benefits gained are not in-kind to those which are lost. This rationale is in keeping with the Fish and Wildlife Service HEP procedures and the Corps of Engineers policy (ER 1105-2-129 paragraph 11C, dated 15 August 1973). Thus, no local cost-sharing is involved in this portion of the project.

2. Evaluation of Stream Characteristics and Fish Populations

A fishery study was conducted during June, 1976 to obtain a data base for developing the aquatic portion of the Fish and Wildlife Compensation Plan for the Twin Valley Lake Project.

Major stream habitat types, fish population characteristics and the stream fishery were evaluated. Stream mapping and mark recapture by electrofishing were used to obtain the necessary data. Sampling stations are shown on Figure 5.

The number and size of pools, riffles and flats (non-riffle and non-pool areas) were determined for each population estimate station. The percent of the total area composed of each type was also determined. Water quality analyses and algae cell counts were obtained for the study area from USGS records.

Species composition, species diversity, catch, length-weight regressions and population estimates for five major species were obtained from five different stations in the study area. Golden redhorse (Moxostoma erythrurum), shorthead redhorse (Moxostoma macrolepidotum), silver redhorse (Moxostoma anisurum), rock bass (Ambloplites rupestris), and northern pike (Esox lucius) formed 83 to 95 percent of the total biomass and an estimated standing crop of 64 to 120 pounds per acre at the 95 percent confidence level. A minimum population estimate for all large fish of other species in the study area was made from actual catches (Table 7).

All habitat requirements for redhorse and rock bass are adequately met in the Wild Rice River. Northern pike lack spawning habitat in the study area but do have adequate spawning areas upstream. Walleye, sauger and catfish were not common in the study area during the survey. Good angling success was reported for walleye, sauger and northern pike in the spring. Critical low flows may be the primary limiting factor for walleye, sauger, and catfish.

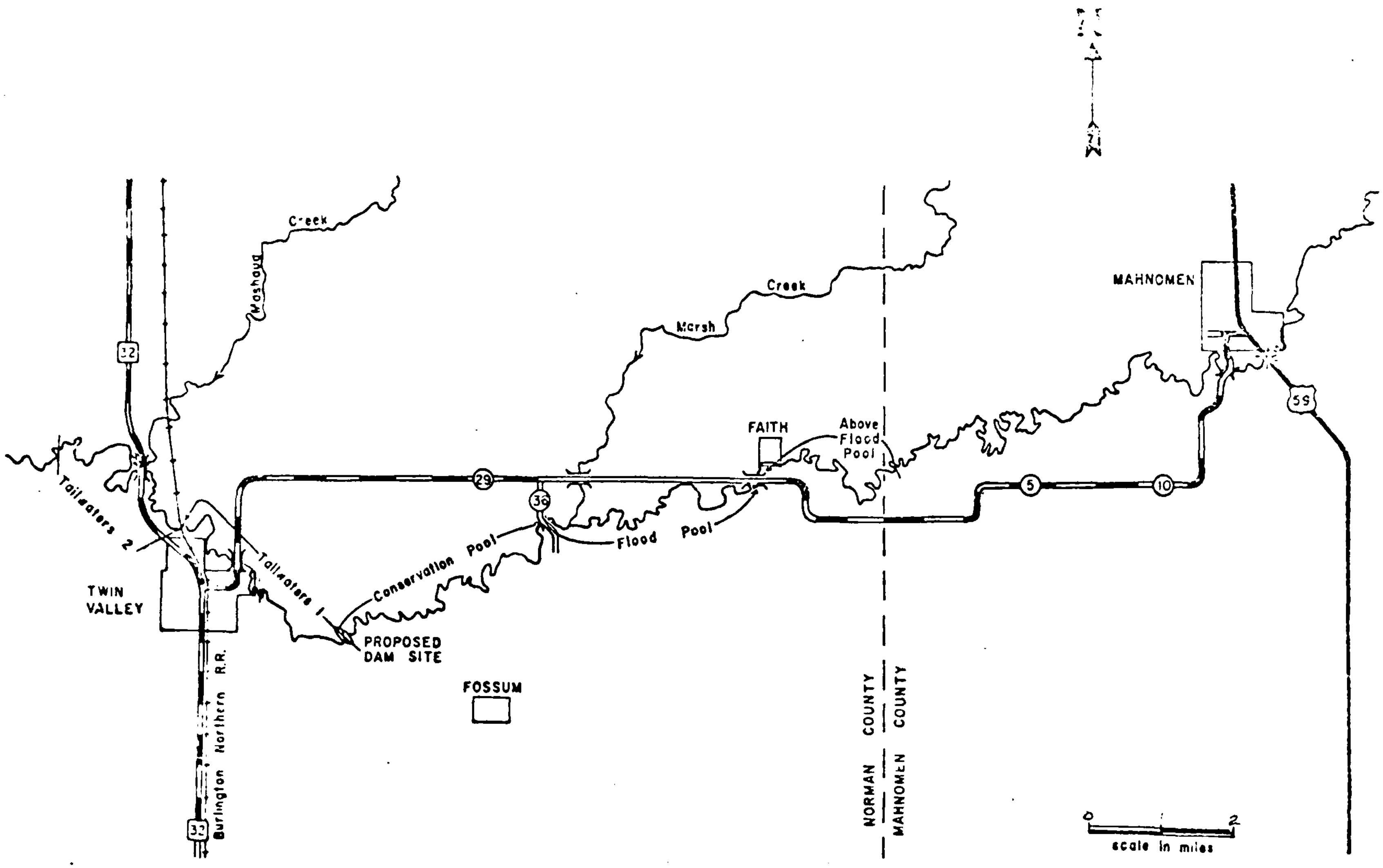


FIGURE 5 LOCATION OF STUDY AREA SHOWING FISH POPULATION STUDY SEGMENTS.

TABLE 7 - POUNDS OF FISH PER ACRE IN FIVE AREAS OF THE WILD RICE RIVER (95% CONFIDENCE INTERVALS)

STREAM STUDY SEGMENT

Species	Above Flood Pool	Flood Pool	Conservation Pool	Tailwaters Number 1	Tailwaters Number 2
Golden redhorse	51.98 (47.05-56.91)	45.92 (41.08-50.76)	48.19 (41.20-55.18)	58.03 (52.45-63.61)	78.78 (68.62-88.94)
Shorthead redhorse	16.30 (13.68-18.92)	13.76 (11.57-15.95)	6.93 (5.57- 8.29)	18.08 (15.52-20.64)	20.31 (17.89-22.73)
Silver redhorse	1.35 (*)	5.40 (5.08- 5.72)	8.88 (6.10-11.66)	12.16 (11.77-12.55)	9.07 (6.73-11.4[illegible])
Rock bass	3.80 (2.17- 5.43)	2.72 (2.21- 3.23)		9.49) (7.23-11.75)	4.99 (3.71- 6.[illegible]
Northern pike	8.05 (4.60-11.50)	5.21 (3.27- 7.15)		6.41 (3.19- 9.63)	6.15 (4.4[illegible]- 7.8[illegible])
Total 5 spp.	81.48 (74.71-88.25)	73.01 (67.33-78.69)	64.00 (56.33-71.65)	104.17 (86.88-111.46)	120.10 (109.19-131.[illegible])
Other species	10.18	8.09	11.57	20.87	6.16
All fish species	**91.66**	**81.10**	**75.57**	**125.04**	**126.26**

3. Aquatic Habitat Evaluation

Aquatic habitats are difficult to evaluate, particularly with regard to assessing changes as a result of the project, determining the amount of compensation needed, and determining the replacement capability of compensation measures. For the Twin Valley Lake Project, HEP provided a general overview of aquatic losses and gains as well as a reasonable comparison of impacts between stream segments.

The first evaluation was prepared by manual calculations. The results of this evaluation indicated that approximately 3,940 habitat units (net annualized) of aquatic habitat would be lost over the life of the project. The second evaluation was prepared using the HEP computer program. Some minor changes were made in both the area and habitat unit value compared to the first evaluation. The results of this evaluation indicated that approximately 3,823 habitat units (net annualized) of aquatic habitat would be lost over the life of the project.

Both evaluations produced similar results. The average of the two evaluations was approximately 3,880 habitat units (net annualized) of aquatic habitat lost.

An analysis of the aquatic and terrestrial future without project conditions (described under Terrestrial Evaluation) indicated that varying trends would result in near-present conditions by year 100. Thus, no change was made to the projected 3,880 habitat units (net annualized) of aquatic habitat lost.

The computer evaluation also determined that 103 acres of additional habitat (replaced in-kind) would be required to compensate for the 3,823 habitat units (net annualized) of aquatic habitat lost.

Tables 8 to 11 represent the HEP computer results for the with and without project conditions. The with project conditions were evaluated through a number of years throughout the 100-year period of analysis. The HU and acreage changes for the Wild Rice River and Twin Valley Lake are noted in each of the tables.

TABLE 8. FUTURE WITHOUT-PROJECT CONDITIONS

HABITAT TYPE	SEGMENT	EXISTING AREA	ANNUALIZED HU CHANGE*	HU VALUE AREA	MANAGEMENT POTENTIAL	AREA FOR COMP
STREAM AFP	1	33.9	0.0	61.7	100.0	0.0
STREAM AFP	TOTAL	33.9	0.0	61.7	100.0	0.0
STREAM FP	2	47.0	0.0	64.1	100.0	0.0
STREAM FP	TOTAL	47.0	0.0	64.1	100.0	0.0
STREAM CP	3	42.3	0.0	62.3	100.0	0.0
STREAM CP	TOTAL	42.3	0.0	62.3	100.0	0.0
STREAM TW1	4	33.2	0.0	63.0	100.0	0.0
STREAM TW1	TOTAL	33.2	0.0	63.0	100.0	0.0
STREAM TW2	5	33.5	0.0	60.7	100.0	0.0
STREAM TW2	TOTAL	33.5	0.0	60.7	100.0	0.0
RESERVOIR	1	0.0	0.0	0.0	100.0	0.0
RESERVOIR	2	0.0	0.0	0.0	100.0	0.0
RESERVOIR	3	0.0	0.0	0.0	100.0	0.0
RESERVOIR	4	0.0	0.0	0.0	100.0	0.0
RESERVOIR	5	0.0	0.0	0.0	100.0	0.0
RESERVOIR	6	0.0	0.0	0.0	100.0	0.0
RESERVOIR	TOTAL	0.0	0.0	0.0	100.0	0.0

*Although the above table indicates that no change in HU's are expected in the Project and Downstream areas of the Wild Rice River over a 100-year period of analysis, changes due to natural successions and man-induced changes are expected. The overall or net changes and the natural variations of the environment are expected to achieve near-present conditions at year 100.

TABLE 9. CHANGES IN THE CONSERVATION POOL FOR THE STREAM AND RESERVOIR HABITATS WITH PROJECT CONDITIONS

HABITAT TYPE	TARGET YEAR	AREA EXIST	AREA CHANGE	AREA NEW	HU VALUE EXIST	HU VALUE CHANGE	HU VALUE NEW	TOTAL HU	NET HU CHANGE
STREAM FP	EXST	47.0			64.1			3013.2	
	5		0.0	47.0		-6.4	57.7	2712.4	-300.8
	10		0.0	47.0		-15.0	49.1	2308.2	-404.2
	20		0.0	47.0		-24.8	39.3	1847.6	-460.6
	50		0.0	47.0		-28.7	35.4	1664.3	-183.3
	100		0.0	47.0		-28.7	35.4	1664.3	0.0
RESERVOIR	EXST	0.0			0.0			0.0	
	10		120.0	120.0		25.0	25.0	3000.0	3000.0
	25		300.0	300.0		35.0	35.0	10500.0	7500.0
	50		580.0	580.0		35.0	35.0	20300.0	9800.0
	75		860.0	860.0		35.0	35.0	30100.0	9800.0
	100		1150.0	1150.0		50.0	50.0	57500.0	27400.0

* *

TABLE 10. CHANGES IN THE FLOODPOOL FOR THE STREAM AND RESERVOIR HABITATS WITH PROJECT CONDITIONS

HABITAT TYPE	TARGET YEAR	AREA EXIST	AREA CHANGE	AREA NEW	HU EXIST	HU CHANGE	HU NEW	TOTAL HU	NET CHANGE
STREAM CP	EXST	42.3			62.3			2636.6	
	0		-42.3	0.0		-62.3	0.0	0.0	-2636.6
	100		-42.3	0.0		-62.3	0.0	0.0	0.0
RESERVOIR	EXST	0.0			0.0			0.0	
	5		540.0	540.0		30.0	30.0	16200.0	16200.0
	10		540.0	540.0		80.0	80.0	43200.0	27000.0
	20		540.0	540.0		70.0	70.0	37800.0	-5100.0
	50		540.0	540.0		45.0	45.0	24300.0	-13500.0
	100		540.0	540.0		45.0	45.0	24300.0	0.0

TABLE 11. CHANGES IN HABITAT UNIT VALUE AND THE AREA FOR COMPENSATION FOR THE FIVE SAMPLING SEGMENTS ON THE WILD RICE RIVER WITH PROJECT CONDITIONS

HABITAT TYPE	SEGMENT	EXISTING AREA	ANNUALIZED HU CHANGE	HU VALUE AREA	MANAGEMENT POTENTIAL	AREA FOR COMP
STREAM AFP	1	33.9	-89.3	61.7	100.0	2.3
STREAM AFP	TOTAL	33.9	-89.3	61.7	100.0	2.3
STREAM FP	2	47.0	-1170.3	64.1	100.0	32.6
STREAM FP	TOTAL	47.0	-1170.3	64.1	100.0	32.6
STREAM CP	3	42.3	-2636.6	62.3	100.0	70.0
STREAM CP	TOTAL	42.3	-2636.6	62.3	100.0	70.0
STREAM TW1	4	33.2	14.8	63.0	100.0	-0.4
STREAM TW1	TOTAL	33.2	14.8	63.0	100.0	-0.4
STREAM TW2	5	33.5	58.9	60.7	100.0	-1.5
STREAM TW2	TOTAL	33.5	58.9	60.7	100.0	-1.5
			3,822.5 H.U.'s lost			103.0 acres of compensation needed 1/

1/ - The gains were subtracted from the losses since the gains were not significant.

* *

TABLE 12. RESULTS OF ACTUAL HABITAT LOST OR DEGRADED IN THE PROJECT AREA.

Stream Segment	Miles Stream Lost	Acres Stream Lost	Total Fish Standing Crop Lost (lbs./acre/year)
Conservation Pool	7.02	42.26	75.57
Flood Pool	3.31	23.52	40.55
Above Flood Pool	0.50	3.39	9.17
Tailwaters 1 and 2	----	-----	-----
TOTAL	10.83	69.17	125.29

4. Evaluation of Actual Habitat Lost in the Project Area

Because it was difficult to evaluate project impacts on aquatic environments based on HEP, an evaluation (by project-segment) of actual acres of habitat lost was also made and is as follows:

a. Conservation Pool

The 540-acre conservation pool would totally destroy 7.02 miles (42.26 acres) of the Wild Rice River. This segment produces a total fish standing crop of 75.57 lbs./acre/year.

The major portion of the standing crop for all of the stream segments is composed of five fish species. These are golden redhorse, shorthead redhorse, silver redhorse, rock bass and northern pike.

b. Flood Pool

Approximately 50 percent of the present value of the Wild Rice River in this segment would be lost over the life of the project. These losses would be highest in the lower 6.61 miles (47.03 acres) of the floodpool stream segment.

The total fish standing crop for this segment is 81.10 lbs./acre/year. Over the life of the project, the loss of standing crop would be 40.55 lbs./acre/year.

c. Above Flood Pool

Approximately 10 percent of the present value of the Wild Rice River in this segment would be lost over the life of the project. These losses would be highest in the lower 5.0 miles (33.92 acres).

The total standing crop for this segment is 91.66 lbs./acre/year. Over the life of the project, the loss of standing crop would be 9.17 lbs./acre/year.

d. Tailwaters 1 and 2

No estimate was made of these losses or gains which depend upon the type of water control structure, quality of water released, and release schedule. Based on previous evaluations, the losses or gains would be minor. Table 12 summarizes the results of actual habitat lost or degraded in the project area. This evaluation alone cannot be used to determine losses, gains or compensation needs because it is highly subjective and does not consider impacts on aquatic species, habitat conditions, and many quantitative parameters. However, this evaluation, in combination with other evaluations, can be used to better define the aquatic habitat losses, gains, and compensation needs.

5. Evaluation of the Potential for Downstream Augmentation

The Wild Rice River below the dam site is considered to have appreciable fishery value, particularly during years of non-critical sustained low flows and little annual variation. The value of the sport fishery is predominantly in spawning and in some forage production, although there are some holding areas and direct sport fishing benefits. The stream fishery compensation recommendations (in Section II) are based (given social/political considerations) on maximum practical management of the stream below the dam in order to compensate for stream fishery losses in the reservoir area. There is therefore a need to consider reservoir releases to agument low flows or a need to provide a functional alternative to low-flow augmentation. The analysis of the reservoir/stream fishery trade-off is discussed below.

Table 13 presents in tabular form the available data pertinent to consideration of reservoir/stream tradeoffs. The data are based on a 30-day low flow period and were drawn in part from three graphs in Design Memorandum No. 1 (reproduced as Figures 6, 7, and 8). Figures 6 and 7 are all-season curves and give a liberal estimate of the fishery benefits of augmentation during critical low-flow periods. Figure 6 does not include losses due to evaporation, leakage or transmission within the reservoir; hence it gives a slightly conservative estimate of the capability for augmentation. Figure 6 estimates uniform yield, which is better than guaranteed low flows; hence it liberally assesses opportunities for augmentation. The overall result from the use of Figures 6 and 7 is that the analysis is liberal and partially over-estimates the stream fishery benefits which could be attained from reservoir releases.

Data are also presented on depths, etc., in the pool after augmentation so that the reservoir fishery value can be judged. Low-flow augmentation would mean lower reservoir stages going into the winter (when inflows are generally less than adequate to refill the reservoir), particularly if augmentation continues into the fall and winter. Lower reservoir stages in winter could increase the chances of fish winterkill.

Data are also presented on the downstream percent of average annual flow, which is an estimator of the downstream fishery benefit of higher reservoir releases. Tennant (1975) maintains that:

(1) Ten percent of average annual flow is the minimum instantaneous flow recommended to sustain short-term survival habitat for most aquatic life forms.

(2) Thirty percent is recommended as a base flow to sustain good habitat survival for most aquatic life forms.

(3) Sixty percent is recommended to provide excellent to outstanding habitat for most aquatic life forms during their primary periods of growth and for the majority of recreational uses.

Table 13, therefore, shows the relationship between the ability of the reservoir to provide x cfs discharged (i.e., low-flow augmentation) during a drought event in order to maintain a survival flow rate (according to Tennant) in the downstream fishery.

TABLE 13. PROBABILITIES OF DROUGHT, STREAM DISCHARGES, PHYSICAL EFFECTS IN RESERVOIR AND STREAM. FISHERY HABITAT RATINGS PERTINENT TO CONSIDERING EFFECTS OF LOW-FLOW AUGMENTATION.

1. Stream discharge below dam[1]	1	5	10	15	20	30
2. Natural percent of time above the value[2]	100	99	94	89+	83+	71+
Percent natural average annual flow in downstream reach[3]	0.6	2.8	5.6	8.5	11.3	16.9
Ratings from Tennant (1975)[4]	< min	< min	< min	< min	> min	> min
Requirements for, and results of, uniform yield at probability:						
3. 20 drought events/100 years						
a. storage volume required[5]	0	0	< 500	1,000	< 2,000	> 4,500
b. volume of permanent pool[6]	7,500	7,500	> 7,000	6,500	> 5,500	< 3,000
c. pool elevation after drawdown[6]	1,063	1,063	1062.3	1061.5	1059.3	1052.1
d. area of permanent pool[6]	540	540	525	500	450	295
e. mean pool depth[7]	13.9	13.9	13.3	13.0	12.2	10.2
f. median pool depth[8]	8.5	8.5	8.5	8.3	8.0	6.1
4. 10 drought events/100 years						
a. storage volume required	0	0	< 500	1,500	< 3,500	< 5,500
b. volume of permanent pool	7,500	7,500	> 7,000	6,000	> 4,000	> 2,000
c. pool elevation after drawdown	1,063	1,063	1,062.3	1,060.4	1,055.3	1,048.3
d. area of permanent pool	540	540	525	480	355	225
e. mean pool depth	13.9	13.9	13.3	12.5	11.3	8.9
f. median pool depth	8.5	8.5	8.5	8.2	7.0	5.5
5. 5 drought events/100 years						
a. storage volume required	0	500	< 1,500	< 3,000	< 5,000	< 7,000
b. volume of permanent pool	7,500	7,000	> 6,000	> 4,000	> 2,500	> 500
c. pool elevation after drawdown	1,063	1,062.3	1,060.4	1,055.3	1,050.5	1,039.0
d. area of permanent pool	540	525	480	355	265	85
e. mean pool depth	13.9	13.3	12.5	11.3	9.4	5.9
f. median pool depth	8.5	8.5	8.2	7.0	5.5	3.5

TABLE 13 (Cont.)

6. 2 drought events/100 years						
a. storage volume required	0	500	<2,000	<4,000	<4,500	<9,500
b. volume of permanent pool	7,500	7,000	>5,500	>3,500	>3,000	*
c. pool elevation after drawdown	1,063	1,062.3	1,059.3	1,053.8	1,052.1	*
d. area of permanent pool	540	525	450	330	295	*
e. mean pool depth	13.9	13.3	12.2	10.6	10.2	*
f. median pool depth	8.5	8.5	8.0	6.4	6.1	*
7. 1 drought event/100 years						
a. storage volume required	<500	<1,000	2,500	<5,000	<7,500	<10,500
b. volume of permanent pool	>7,000	>6,500	5,000	>2,500	0	*
c. pool elevation after drawdown	1,062.3	1,061.5	1,058	1,050.5	1,028	*
d. area of permanent pool	525	500	425	265	5	*
e. mean pool depth	13.3	13.0	11.8	9.4	0	*
f. median pool depth	8.5	8.3	7.5	5.5	0	*

* Augmentation to this extent for this drought event not physically possible.

FOOTNOTES FOR TABLE 13

1. In cubic feet per second - cfs.

2. Percent of time that the discharge is above the indicated discharge, which is based on extrapolations from discharge estimates under natural conditions, Figure 7.

3. Compared to 177-cfs average annual flow from a 53-year period of USGS records.

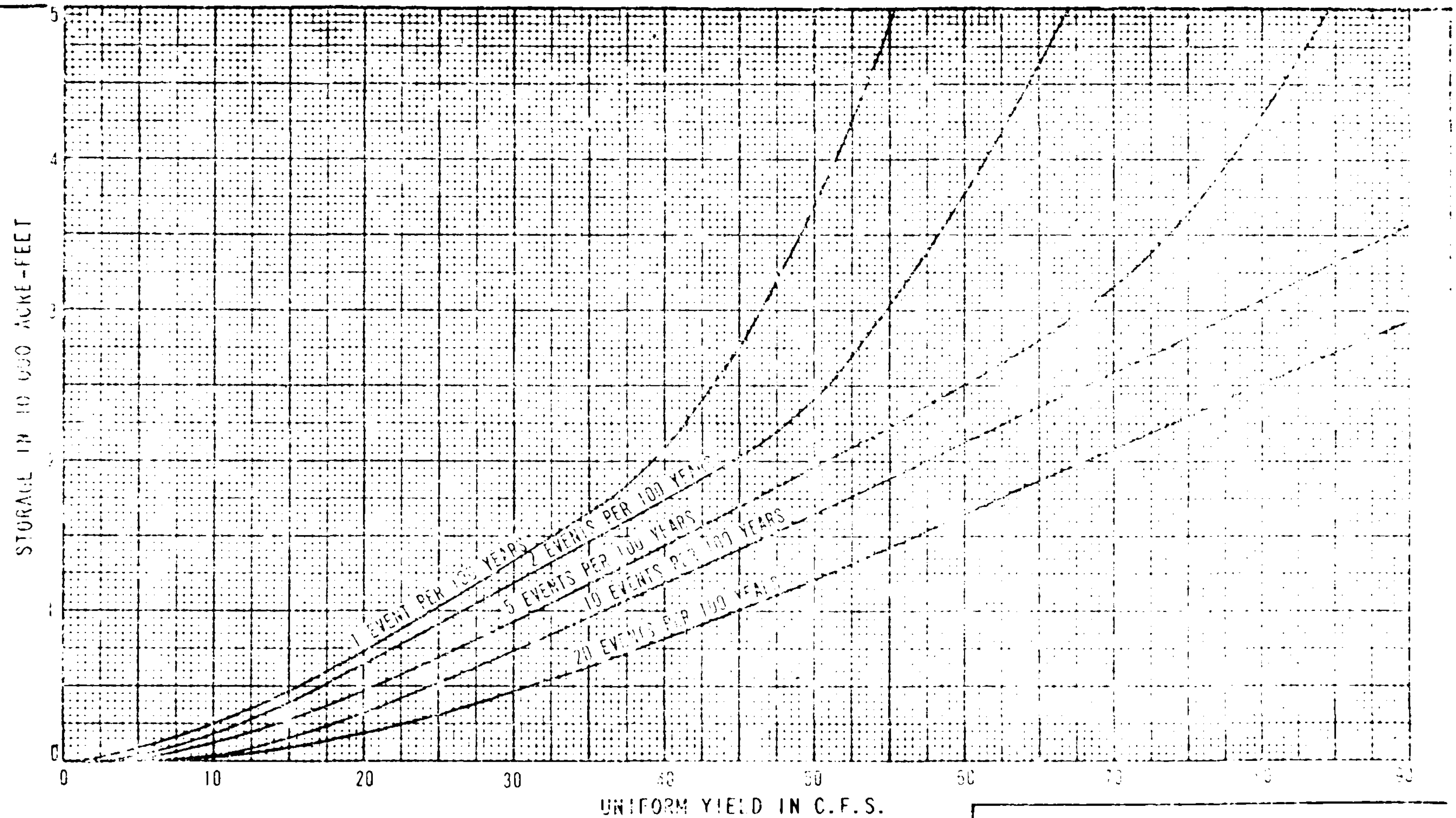
4. From Tennant (1975). Instream flow regimens for fish, wildlife, recreation and related environment resources (The Montana Method).

5. Acre-feet of storage required for uniform yield in cfs (from Figure 6) which overestimates the ability to provide guaranteed low flows due to Figure 6 including data from spring high-flow periods.

6. From Figure 8; volume (in acre feet) and surface area (in acres) are on the horizontal, and elevation is on the vertical.

7. Mean pool depth = volume of permanent pool/area of permanent pool.

8. Median pool depth = elevation of pool after drawdown - elevation of one half of the volume of permanent pool (from Figure 8).

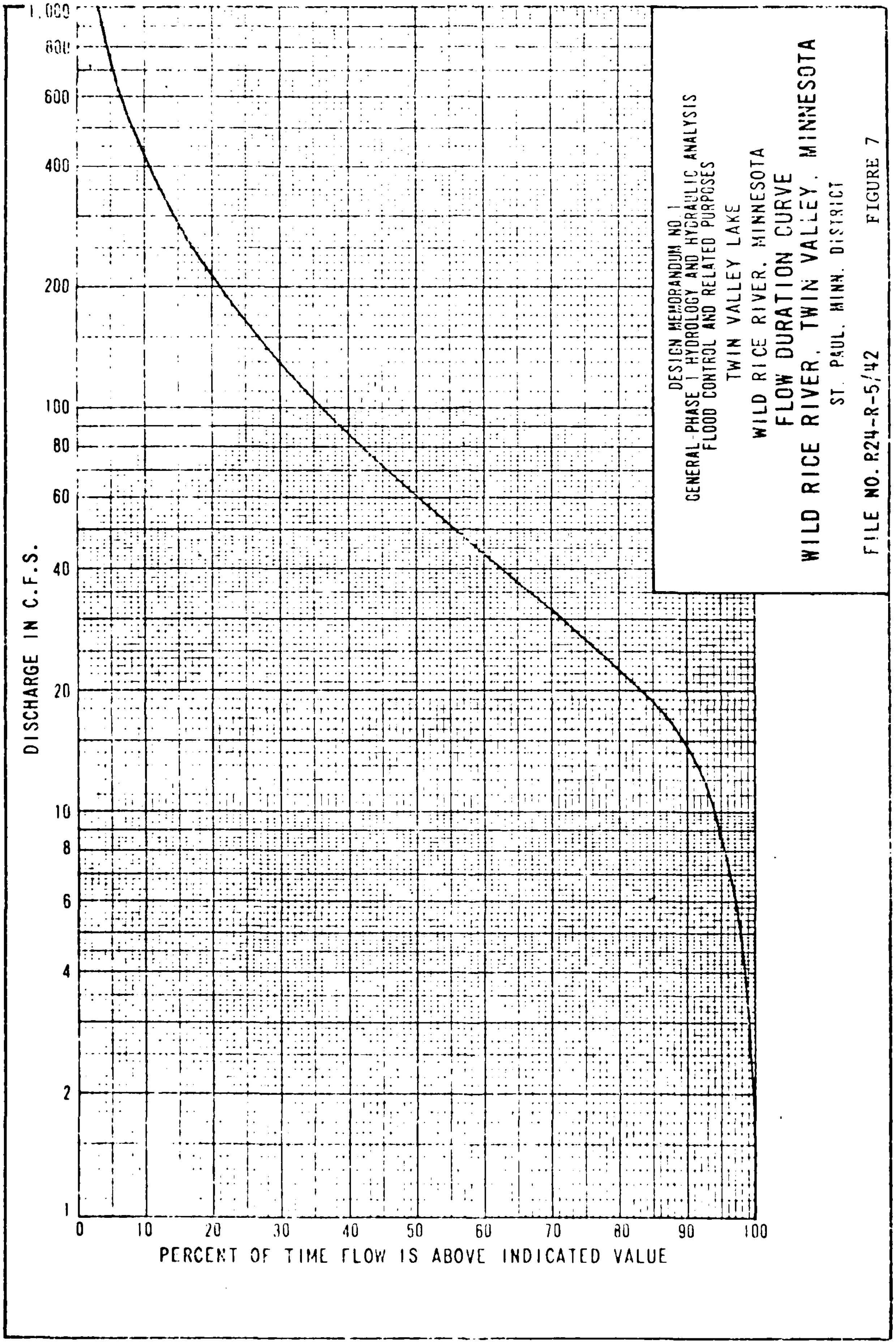


NOTES:

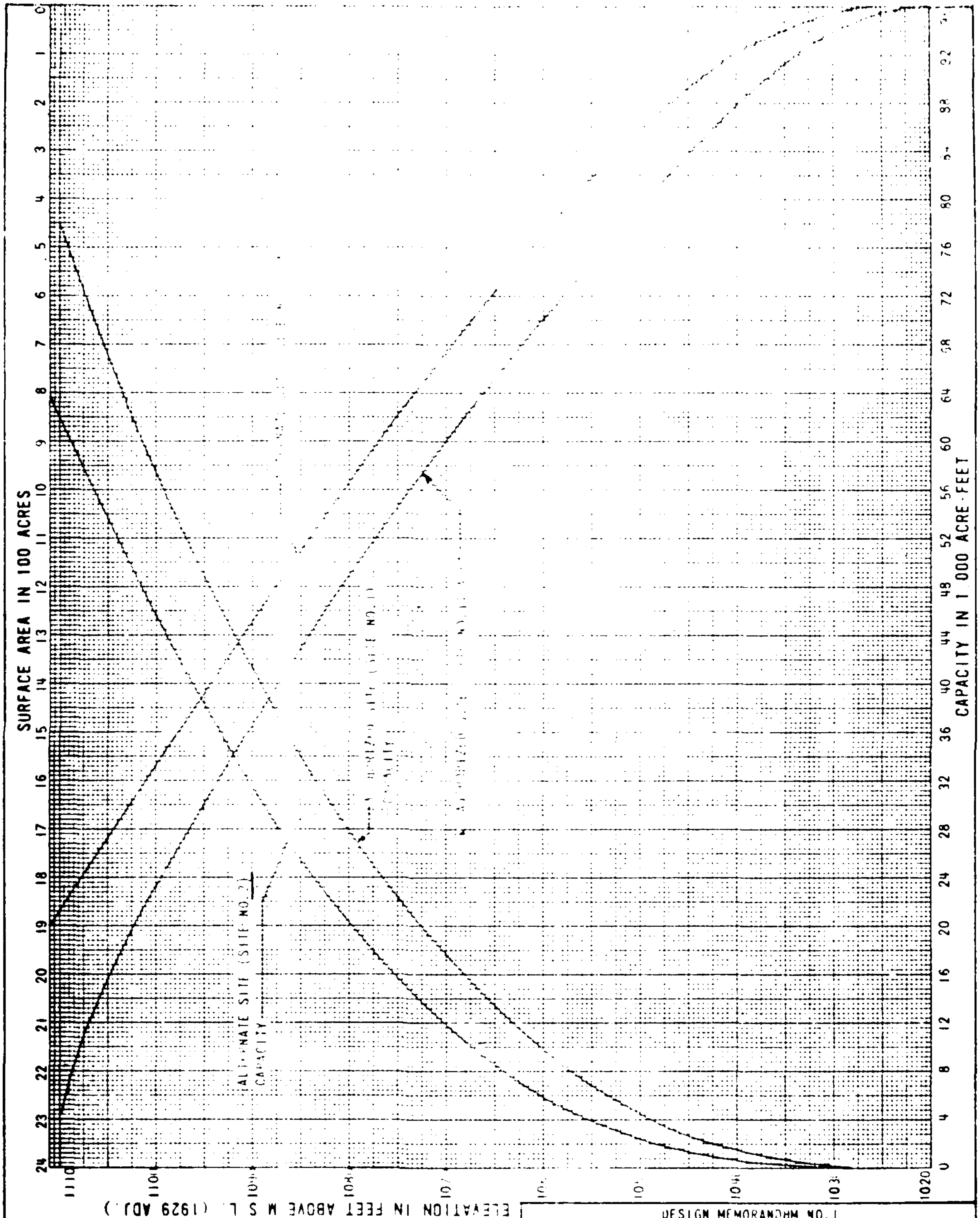
1. PARAMETER IS NON-EXCEEDENCE FREQUENCY IN EVENTS PER 100 YEARS

2. CURVES DO NOT INCLUDE LOSSES TO EVAPORATION, LEAKAGE OR TRANSMISSION WITHIN THE RESERVOIR.

DESIGN MEMORANDUM NO. 1
GENERAL PHASE I HYDROLOGY AND HYDRAULIC ANALYSIS
FLOOD CONTROL AND RELATED PURPOSES
TWIN VALLEY LAKE
WILD RICE RIVER, MINNESOTA
STORAGE-YIELD CURVES
WILD RICE RIVER AT TWIN VALLEY
ST. PAUL, MINN. DISTRICT
FILE NO. 824-R-5/[illegible] FIGURE 6



DISCHARGE IN C.F.S.
1,000
800
600
400
200
100
80
60
40
20
10
8
6
4
2
1
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF TIME FLOW IS ABOVE INDICATED VALUE
DESIGN MEMORANDUM NO. 1
GENERAL-PHASE I HYDROLOGY AND HYDRAULIC ANALYSIS
FLOOD CONTROL AND RELATED PURPOSES
TWIN VALLEY LAKE
WILD RICE RIVER, MINNESOTA
FLOW DURATION CURVE
WILD RICE RIVER, TWIN VALLEY, MINNESOTA
ST. PAUL, MINN. DISTRICT
FILE NO. R24-R-5/42
FIGURE 7



DESIGN MEMORANDUM NO. 1
GENERAL-PHASE I HYDROLOGY AND HYDRAULIC ANALYSIS
FLOOD CONTROL AND RELATED PURPOSES
TWIN VALLEY LAKE
WILD RICE RIVER MINNESOTA

AREA CAPACITY CURVES
TWIN VALLEY RESERVOIR (SITES I AND 2)

ST. PAUL, MINN. DISTRICT

FILE NO R24-R-5/43 FIGURE 8

a. Conclusions

Inspection of the data in Table 13 reveals that downstream fishery benefits from low-flow augmentation would be very modest at best. Further, the augmentation would come at the considerable expense of the reservoir fishery and water-based recreation. As an alternative, raising the permanent pool would be at the expense of terrestrial habitat types and available flood control storage, and would basically provide minimal benefit to the downstream fishery. Since the bulk of aquatic recreation benefits and losses of the project are heavily in favor of managing the fishery and recreation in the reservoir instead of the downstream reaches, low-flow augmentation is not considered a reasonable management objective. The only case where it could be recommended is the case where the aquatic mitigation plan must strive at an all-out cost to achieve the theoretical MPUV of 100.

An alternative to low-flow augmentation is to provide scour holes downstream of the reservoir stilling basin and at points where there are instream structures for fish habitat improvement. Scour holes can be incorporated into the recommended plan for bank protection, wing dams, and artificial riffles, etc. Scour holes below stream habitat improvements are to a large extent automatically provided for through their design. Ongoing design studies will also strive to provide a scour hole below the reservoir stilling basin which is consistent with concerns for public access and safety, yet protects the fish stock from over-exploitation.

The concept of scour holes is recognized as only a partial alternative to appreciable low-flow augmentation because scour holes would contain less forage and would function mainly as fish holding areas. Ultimately the fish production within the stream would show an overall increase with low-flow augmentation. This constraint is recognized in the aquatic MPUV analysis.

These judgments and reliances on the scour hole concept as an alternative to low-flow augmentation are based entirely on the evaluation of flow data and related effects. The practicality of this decision necessarily depends upon other considerations, such as whether the usual dissolved oxygen sag downstream of the outlet would allow suitable conditions in scour holes for fish during low flows. As a result, this analysis must necessarily remain somewhat speculative due to its complexity and basically unknown factors, especially ecological reactions and future project design changes and refinements. Operational experience may also suggest refinements and/or indicate a need to change the fishery management plans.

III. SELECTION AND EVALUATION OF COMPENSATION AREA ALTERNATIVES

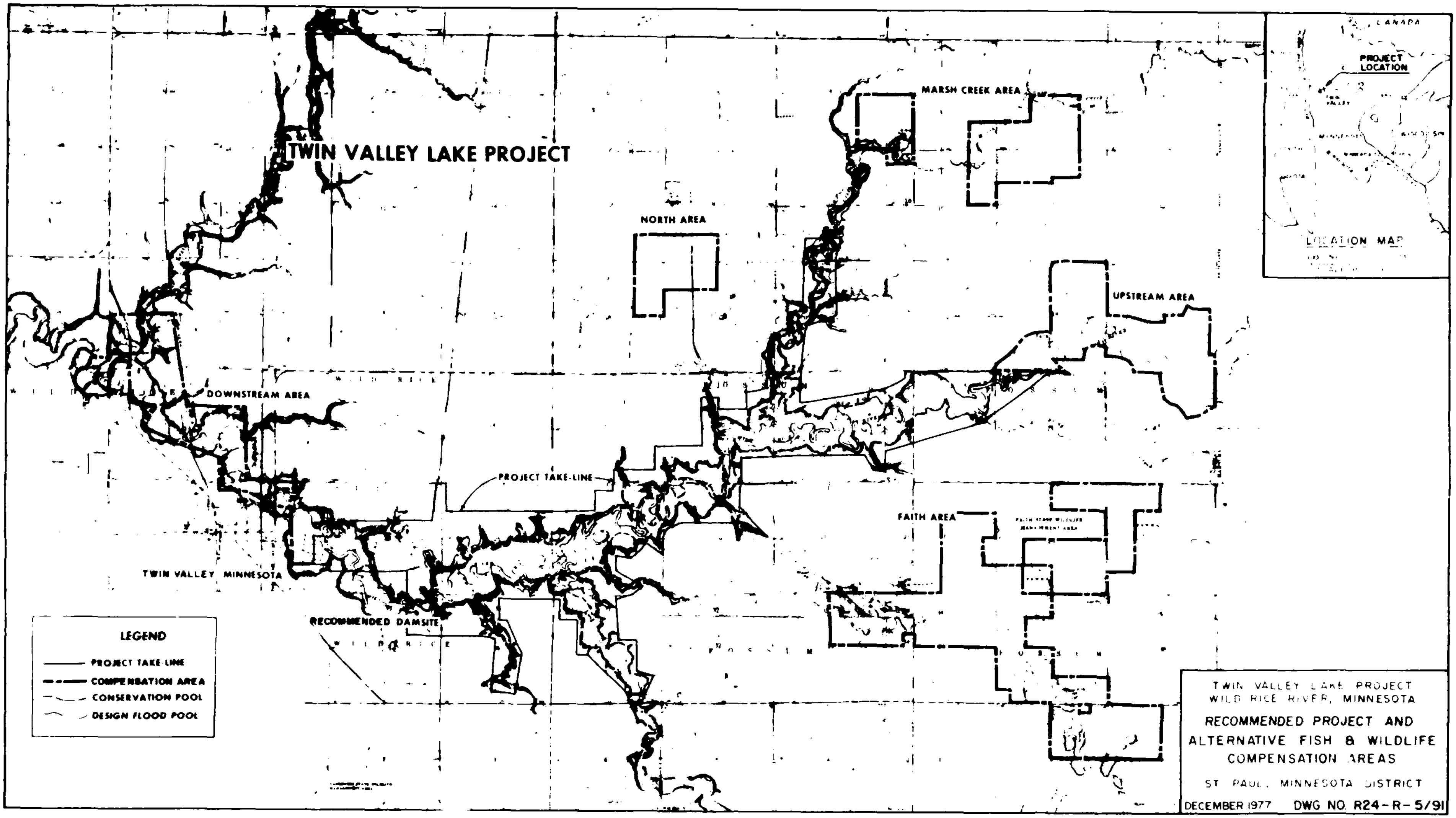
A. Selection of Compensation Area Alternatives

In the initial stages of the HEP analysis (i.e., during the initial survey using terrestrial maps and aerial photographs) a determination was made of the actual number of HU's that would be lost in the project area (conservation pool) and how many HU's the remaining project land would yield. As the studies progressed, it became apparent that the approximate size and location of potential compensation areas also needed to be identified so that the best possible HEP evaluation would be made of their existing habitat conditions and predicted 100-year changes. Thus, a preliminary estimate of compensation needs could be generated and evaluated to determine the size, range, and scope of the final compensation plan.

Based on discussions with the Twin Valley Citizens Advisory Committee, Minnesota Department of Natural Resources (regional and area personnel) and investigations of the interagency team, five initial terrestrial habitat compensation areas were considered. These large initial areas were the Faith area, Upstream floodplain area, North area, Marsh Creek area, and the Downstream floodplain area (see Figure 9).

Each of the five areas were divided into 40-acre plots and evaluated using a scale of 1 to 4, with 1 being the best existing wildlife habitat and usually the least expensive to acquire. Whenever the criteria created a choice conflict, consideration was given first to cost of acquisition. The evaluation codes and criteria are as follows:

Evaluation Code	Criteria
1	0-5 percent cropland or grassland. Least expensive to acquire. High social acceptability.
2	0-10 percent cropland and 5-25 percent grassland.
3	0-25 percent cropland and 25-100 percent grassland.
4	All habitats up to but not exceeding 50 percent cropland (beyond 50 percent not considered). Most expensive to acquire. Least social acceptability.


TWIN VALLEY LAKE PROJECT
MARSH CREEK AREA
NORTH AREA
UPSTREAM AREA
DOWNSTREAM AREA
PROJECT TAKE-LINE
FAITH AREA
TWIN VALLEY MINNESOTA
RECOMMENDED DAMSITE
CANADA
PROJECT LOCATION
LOCATION MAP
LEGEND
PROJECT TAKE LINE
COMPENSATION AREA
CONSERVATION POOL
DESIGN FLOOD POOL
TWIN VALLEY LAKE PROJECT
WILD RICE RIVER, MINNESOTA
RECOMMENDED PROJECT AND
ALTERNATIVE FISH & WILDLIFE
COMPENSATION AREAS
ST. PAUL, MINNESOTA DISTRICT
DECEMBER 1977 DWG NO. R24-R-5/91
FIGURE 9

Based on the above criteria, the following initial terrestrial compensation alternatives were considered:

Alternative A - Faith Area
Total Area Under Consideration - 3,150 acres
Recommended for Further Analysis - 1,751 acres

Alternative B - North Area
Total Area Under Consideration - 2,130 acres
Recommended for Further Analysis - 280 acres

Alternative C - Marsh Creek Area
Total Area Under Consideration - 1,350 acres
Recommended for Further Analysis - 620 acres

Alternative D - Downstream Floodplain Area
Total Area Under Consideration - 1,475 acres
Recommended for Further Analysis - 740 acres*

Alternative E - Upstream Floodplain Area
Total Area Under Consideration - 700 acres
Recommended for Further Analysis - 700 acres

Thus, the above potential terrestrial compensation areas were generally selected on the basis of having low acquisition costs, having habitat types as similar as possible to the habitats lost, having a high social acceptability and a low social-economic effect (i.e., large croplands, farmsteads, and home sites were avoided as much as possible), and having a potential and practicality for further wildlife management. Table 14 shows the results of the terrestrial habitat inventory for the potential compensation areas.

3. Evaluation of Compensation Area Alternatives

HEP form 3-1101 was prepared for the Faith area and North area alternatives. The Upstream and Marsh Creek areas were considered to have habitat conditions similar to the North area and were therefore included in the HEP forms for that area. Form 3-1101 for the Downstream floodplain area was assumed to be the same as for the project area since habitat conditions and wildlife populations appeared to be quite similar.

*The average presented here is used throughout the remainder of the HEP analysis, but it is not the total acreage that will be recommended for acquisition. The actual figure will be somewhat less.

TABLE 14. EXISTING TERRESTRIAL HABITAT CONDITIONS - PROJECT AREA AND COMPENSATION ALTERNATIVE AREAS

Habitat	Project Area	Faith Area	Downstream Floodplain Area	North Area	Marsh Creek Area	Upstream Floodplain Area
Upland Hardwood	931.7	147.0	202.0	20.0	425.0	290.0
Lowland Hardwood	1,038.3	97.0	257.0	15.0	20.0	230.0
Oxbows	45.2	------	11.0	-----	-------	20.0
Upland Brush	44.0	------	10.0	35.0	10.0	5.0
Lowland Brush	64.3	------	16.0	-----	10.0	5.0
Grassland	217.0	616.0 1/	53.0	75.0	85.0	10.0
Cropland	618.5	447.0	143.0	50.0	35.0	50.0
Streambank	184.2	------	46.0	-----	35.0	90.0
Type 6 Wetland	8.0	39.0	2.0	-----	-------	------
Type 2 Wetland	-------	43.0	------	70.0	-------	------
Type 3/4 Wetland	-------	319.0	------	15.0	-------	------
Type 5 Wetland	-------	43.0	------	-----	-------	------
TOTAL ACRES	3,151.2	1,751.0	740.0	280.0	620.0	700.0

1/ Also includes varying amounts of brushland.

1. Sites Unsuitable for Compensation Areas

After the initial HEP analysis was performed in the field, it was realized that the North, Marsh Creek, and Upstream areas would be unsuitable as compensation sites for the following reasons:

a. The Marsh Creek and North areas contained larger acreages of pasture (heavily grazed) and cropland than were indicated on the USGS maps.

b. The farmsites were more highly developed and/or were in the process of further development. Therefore, these areas were moving towards a more intensive agricultural area than was first anticipated.

c. Many of the wetlands, which were indicated on the USGS maps, had already been drained and were being used for other purposes (such as cropland).

d. The Upstream area was not selected as a compensation area because the interagency team believed it would be more desirable for management purposes to deal with one large block of land in the Faith area rather than a few smaller blocks of land in both the Faith and Upstream areas.

Due to the above factors, the available wildlife habitat has been greatly reduced in the North and Marsh Creek areas. The remaining land was located in small, 200 to 400 acre plats which were isolated from one another. In order to manage these areas, an easement would be necessary to obtain access to them. Thus, the interagency team felt that these areas would not produce the necessary benefits for wildlife and would probably disrupt the farming practices being developed in those areas.

2. Sites Suitable for Compensation Areas

The Faith area and the Downstream area appeared to be the best areas for further consideration and for compensation for the following reasons:

a. Lands developed for agricultural purposes in the Faith area were marginal as compared to the other areas.

b. Many of the wetlands that were indicated on the USGS maps were still in existence and thus could be more easily and effectively upgraded for wildlife through management.

c. A large amount of land, approximately 1,751 acres, could be obtained in the area which could be managed for wildlife and would complement the existing Faith Wildlife Management Area.

d. The Downstream area would continue to provide wintering habitat for deer and also compensate for some of the aquatic habitat losses expected to result from project construction.

e. Acquisition of the Downstream area would reduce the potential for further development in the valley.

f. Recreational development would be enhanced due to the existence of the Heiberg Dam downstream and the reservoir upstream.

Because of the above data and criteria previously discussed, the Faith area and the Downstream area were selected by the interagency team as potential terrestrial compensation areas. Acreages recommended for further analysis for these two areas were determined by making preliminary calculations through the final step, using HEP. These areas are as follows:

Faith area(Alternative A)	1,751 acres
Downstream floodplain area (Alternative D)	740 acres
Total	2,491 acres

C. Management Potential Unit Value Analysis

The management potential unit value (MPUV) was the basic unit used to calculate compensation gains as a result of management. The MPUV analysis was completed only on the Project area, Faith area, and Downstream area.

The following general assumptions and criteria were used to determine the Management Potential Unit Value:

1. Habitat Unit Value represents an average value for the total evaluation elements (species). Because it is highly improbable that all species would respond exactly the same to a particular management measure, the Management Potential Unit Value plus the Habitat Unit Value will rarely equal 100 (full potential) since full management for one species would probably conflict with another species.

2. The Management Potential Unit Value plus Habitat Unit Value may not always be equal to the highest habitat total value of a given sample site. This is because the sample sites often varied considerably between each other due to numerous bio-geophysical differences.

3. Management potential was considered with respect to all of the evaluation elements (species) as if each were equally as important as the other.

4. The intensity of management considered was based on existing Federal and State wildlife management activities which were actually being accomplished or which could reasonably be undertaken in western Minnesota today with minimal funds and manpower. The interagency team assumed these same activities can be accomplished in the project area in the future.

5. Habitat improvement (management) measures which could change the habitat from one type to another were not considered.

6. The terrestrial habitat types in the Downstream floodplain area were assumed to be in the same proportion as those in the floodpool of the Project area. Therefore, the Management Potential Unit Value for the Downstream floodplain area was considered the same as for the floodplain of the Project area.

Table 15 identifies the MPUV per habitat type found in the Project, Downstream, and Faith areas. Table 16 summarizes the terrestrial management measures which could be implemented on the Project area, Faith area, and Downstream floodplain area. Table 18 summarizes the total HU's which could be gained from applying the MPUV measures presented in Table 16.

D. Delay in Habitat Units from Management

There would be a delay in the flow of benefits from management. Any type of management practice and habitat type conversion, such as cropland to grassland or woodland would require time to become most effective. Also some of the management measures are on a long-term rotational basis (see Table 16, Habitat Improvement Measures) and the full benefit would accrue well into the period of analysis. These effects were annualized as shown below.

Average Annual Management Benefits:

$$\frac{1/2\ (\text{MPUV x rotation period (years)}) + (\text{MPUV x years remaining after first rotation period})}{\text{Period of analysis (years)}}$$

This method of computing the average annual management benefits was chosen because it is computationally simpler, does not need revision as interest rates change, and was used throughout the HU analysis.

Table 17 represents the average annual management benefits that would be delayed when implementing the management practices for the different habitat types in the Project (Floodpool and Takeline Areas), Faith, and Downstream Areas.

Table 18 shows the Habitat Units gained through management on each habitat type in the Project (Floodpool and Takeline Areas), Faith, and Downstream areas. Those HU's delayed from Table 17 were substracted from the total HU's gained through management to give the overall HU gains from management.

TABLE 15. MPUV PER HABITAT TYPE IN THE PROJECT, DOWNSTREAM, AND FAITH AREAS

Habitat Types	Management Potential Unit Value		
	Project Area[1/]	Downstream Area	Faith Area [1/]
Upland Hardwood	12.2	12.2	8.3
Lowland Hardwoods	5.4	5.4	
Lowland Hardwoods (Beyond Valley)			10.0
Oxbows	22.1	22.1	
Upland Brush	17.5	17.5	
Lowland Brush	8.5	8.5	
Grassland	15.0	15.0	7.7
Cropland	15.6	15.6	14.7
Streambank	7.2	7.2	
Type 6 Wetland	8.8	8.8	8.0
Type 2 Wetland			9.0
Type 3/4 Wetland			18.0
Type 5 Wetland			9.7

[1/] MPUV obtained from the original HEP forms No. 3-1101.

TABLE 16. TERRESTRIAL HABITAT IMPROVEMENT MEASURES IN THE PROJECT AREA AND COMPENSATION AREAS BASED ON THE MPUV ANALYSIS

HABITAT	HABITAT IMPROVEMENT MEASURES					
	Create forest openings	Retain dead trees snags	Seed trails with grasses and legumes	Eliminate or reduce grazing	Plug oxbow outlets	Plug wetland outlets
	ACRES/20 YRS.	--------	MILES/5 YRS.	---------	NO. PLUGS/25 YRS.	NO. PLUGS/50 YRS
Upland Hardwood	26	X	[illegible]	X	-----	-----
Lowland Hardwood	26	X	-----	X	-----	-----
Oxbows	9	X	-----	-----	8	-----
Upland Brush	-----	-----	½	X	-----	-----
Lowland Brush	-----	-----	½	X	-----	-----
Grassland	-----	-----	-----	X	-----	-----
Cropland	-----	-----	-----	-----	-----	-----
Streambank	10	X	-----	-----	-----	-----
Type 6 Wetland	-----	-----	-----	X	-----	-----
Type 2 Wetland	-----	-----	-----	X	-----	-----
Type 3/4 Wetland	20	-----	-----	X	-----	5
Type 5 Wetland	2	-----	-----	X	-----	1
TOTAL	93	X	3-3/4	X	8	6

TABLE 16. (Continued)

HABITAT	Create rock and brush piles	Plant trees and shrubs	Trim/mow brush	Plant grasses, legumes, or crops (non-trail)	Backslope eroded banks	Erect Wood Duck boxes	Conduct periodic burning	Excavate potholes
	----------	ACRES/25 YRS.	ACRES/5 YRS.	ACRES/YR	SQ.FT/20 YRS.	NO.BOXES/10 YRS.	ACRES/3 YRS.	NO./[illegible] YRS.
Upland Hardwood	-----	-----	-----	-----	-----	-----	-----	-----
Lowland Hardwood	-----	-----	-----	-----	-----	5	-----	-----
Oxbows	-----	-----	-----	-----	-----	-----	-----	-----
Upland Brush	X	5	-----	-----	-----	-----	-----	-----
Lowland Brush	-----	-----	2	-----	-----	-----	-----	-----
Grassland	-----	-----	-----	65	-----	-----	82	-----
Cropland	-----	-----	-----	225	-----	-----	-----	-----
Streambank	-----	-----	-----	-----	7,000	25	-----	-----
Type 6 Wetland	-----	-----	2½	-----	-----	-----	10	-----
Type 2 Wetland	-----	-----	-----	-----	-----	-----	5	2
Type 3/4 Wetland	-----	-----	-----	-----	-----	-----	-----	-----
Type 5 Wetland	-----	-----	-----	-----	-----	-----	-----	-----
TOTAL	X	5	4½	290	7,000	30	97	2

TABLE 16. (Continued)

HABITAT	Install nesting/ loafing sites	Divert ditch flows	Seek water-shed erosion control
	NO. SITES/5 YRS.	MILES/20 YRS.	----------
Upland Hardwood	-----	-----	-----
Lowland Hardwood	-----	-----	-----
Oxbows	-----	-----	-----
Upland Brush	-----	-----	-----
Lowland Brush	-----	-----	-----
Grassland	-----	-----	-----
Cropland	-----	-----	X
Streambank	-----	-----	-----
Type 6 Wetland	-----	-----	-----
Type 2 Wetland	-----	-----	-----
Type 3/4 Wetland	10	½	X
Type 5 Wetland	2	¼	X
TOTAL	12	3/4	X

TABLE 17. MPU'S LOST DUE TO A DELAY IN THE FLOW OF HU'S FROM MANAGEMENT IN THE PROJECT, FAITH AND DOWNSTREAM AREAS

Habitat Type	TAKELINE AREA				FLOODPOOL AREA				FAITH AREA				DOWNSTREAM AREA				TOTAL HU's
	MPUV	Avg. Ann. MPUV	Decrease as Avg. Ann. MPUV %	HU's	MPUV	Avg. Ann. MPUV	Decrease as Avg. Ann. MPUV %	HU's	MPUV	Avg. Ann. MPUV	Decrease as Avg. Ann. MPUV %	HU's	MPUV	Avg. Ann. MPUV	Decrease as Avg. Ann. MPUV %	HU's	
1. Upland Hardwood	12.2	7.2	28	1766	6.1	4.3	30	524	8.3	5.3	36	439	12.2	7.2	28	690	3,419
2. Lowland Hardwood (in valley)	5.4	4.1	24	135	2.7	2.0	26	409					5.4	4.1	24	333	877
2b. Lowland Hardwood (beyond valley)									10.0	7.0	30	291					291
3. Oxbows	22.1	12.5	43	76	11.1	6.3	43	52					22.1	12.5	43	104	232
4. Upland Brush	17.5	14.1	19	93	8.8	7.1	19	25					17.5	14.1	19	33	151
5. Lowland Brush	8.5	6.5	24	4	4.3	3.2	26	25					8.5	6.5	24	33	62
6. Grassland	15.0	10.8	28	424	7.5	5.4	28	189	7.7	6.2	19	901	15.0	10.8	28	223	1,737
7. Cropland	15.6	15.6	0	0	7.8	7.8	0	0	14.7	14.7	0	0	15.6	15.6	0	0	0
8. Streambank	7.2	5.1	29	21	3.6	2.5	31	104					7.2	5.1	29	96	221
9. Type 6 Wetland					4.4	3.2	27	9	8.0	6.0	25	78	8.8	6.3	28	5	192
10. Type 2 Wetland									9.0	6.2	31	120					120
11. Type 3/4 Wetland									18.0	10.4	42	2412					2,412
12. Type 5 Wetland									9.7	6.2	36	150					150
TOTALS				2,519				1,337				4,391				1,517	9,764

TABLE 18 HABITAT UNITS GAINED FROM COMPENSATION AREAS THROUGH MANAGEMENT

HABITAT TYPE	Faith Area ACRES	Faith Area MPUV	Faith Area HU'S	Downstream Area ACRES	Downstream Area MPUV	Downstream Area HU'S	Takeline Area ACRES	Takeline Area MPUV	Takeline Area HU'S	Floodpool Area ACRES	Floodpool Area MPUV	Floodpool Area HU'S	Total HU'S	Total HU's From Table 17	Total HU's
1 Upland Hardwood	147	8.3	1220	202	12.2	2464	517	12.2	6307	286	6.1	1745	11736	3419	8317
2a Lowland Hardwood (in valley)	0	0	0	257	5.4	1388	104	5.4	562	583	2.7	1574	3524	877	2647
2b Lowland Hardwood (beyond valley)	97	10.0	970	0	0	0	0	0	.0	0	0	0	970	291	679
3 Oxbows	0	0	0	11	22.1.	243	8	22.1	177	11	11.1	122	542	232	310
4 Upland Brush	0	0	0	10	17.5	175	28	17.5	490	15	8.8	132	797	151	646
5 Lowland Brush	0	0	0	16	8.5	136	2	8.5	17	22	4.3	95	248	62	186
6 Grassland	616	7.7	4743	53	15.0	795	101	15.0	1515	90	7.5	675	7728	1737	5991
7 Cropland	447	14.7	6571	143	15.6	2231	478	15.6	7457	44	7.8	343	16602	0	16602
8 Streambank	0	0	0	46	7.2	331	10	7.2	72	93	3.6	335	738	221	517
9 Type 6 Wetland	39	8.0	312	2	8.8	18	0	0	0	8	4.4	35	365	92	273
10 Type 2 Wetland	43	9.0	387	0	0	0	0	0	0	0	0	0	387	120	267
11 Type 3/4 Wetland	319	18.0	5742	0	0	0	0	0	0	0	0	0	5742	2412	3330
12 Type 5 Wetland	43	9.7	417	0	0	0	0	0	0	0	0	0	417	150	267
														Total	40,032

E. Comparison of Unlike Habitat Types

Due to the extent of riparian habitat expected to be lost in the project area and the inability of remaining lands to provide in-kind replacement, other habitat types had to be considered in order to obtain the required compensation.

The HEP analysis, as with other existing methods of analysis, does not provide a procedure for compensation when comparing "not-in-kind" replacement or improvement of other habitat types. It was felt that, if the remaining land and its associated habitat units could be developed into habitat units similar to those which would be lost, then a trade-off between like and unlike habitat types could occur. The tri-agency team therefore developed a system of comparison ratios and critical factors for this purpose.

The comparison ratio system is based on the survival capabilities and utilization potential that each of the different habitat types would provide for all of the species (in each habitat type) evaluated in the HEP analysis. A numerical rating, based on a scale of 1 to 10, was given to those habitat types in both the project and compensation areas for the nine comparison ratio criteria factors discussed below.

1. Comparison Ratio Criteria Definitions

a. Relative Abundance

The relative abundance of a habitat type related to its former abundance in the recent past within a few miles of the project area.

0 - little or no loss 10 - much loss

b. Vulnerability to Adverse Change

How vulnerable habitat type is to adverse changes such as grazing, drainage, clearing, etc. (land use).

0 - low 10 - high

c. Food & Cover Capability

Present capability of each habitat type to provide food and cover for key species compared to other types.

0 - low 10 - high

d. Reproductive Value

The value of each habitat type for courting, nesting, and rearing young of key species.

0 - low 10 - high

e. <u>Non-reproductive Value</u>

The ability to absorb the more mobile wildlife populations for family group breakups, yarding, staging, and migration.

0 - low   10 - high

f. <u>Meeting Other Environmental Needs</u>

The ability to maintain water quality; to provide aesthetic setting, components of fish habitat, and access to outdoor recreation; and to withstand increasing recreational use.

0 - low   10 - high

g. <u>Labor-Intensive Management Potential</u>

Derived from MPUV: 0 $\leq$ 2 MPUV, 2 $\leq$ 6 MPUV, 4 $\leq$ 10 MPUV, 6 $\leq$ 14 MPUV, 8 $\leq$ 18 MPUV, 9 $\leq$ 20 MPUV, 10 $<$ 20 MPUV

h. <u>Capital-Intensive Management Potential</u>

Structural habitat improvement measures which may include water development, creation of islands and stream habitat improvement.

0 - no potential   10 - high potential

i. <u>Critical Factors</u>

Once the subtotal ratio for each habitat type had been determined, the triagency team felt that some of the habitat types critical for wildlife survival were not accurately represented by the ratios because of their limited availability. As a result, a critical factor was applied to those habitat types having a substantial ecological value or benefit to the terrestrial vertebrates, which had not been previously considered in the field evaluation or by the comparison factors. The habitats involved were those habitats which would significantly affect wildlife populations by decreasing the available cover, sources of food, and living space. The loss and degradation of these habitats would force the existing populations into those areas which would otherwise be unaffected by the project. In the long term, the number of animals would likely decrease. It is hard to estimate the actual losses that would occur as a result of the project and it is harder yet to place a value on those losses; however, the critical factors were developed in an attempt to show such an effect on the wildlife populations.

The effects on the recreational value brought about by the degradation and loss of habitat within the valley were also documented in the monetary analysis. Even though the recreational demand curves assumed no further change after 20 years, demand exceeded supply for the major species, a supply which was diminishing.

(1) Lowland Hardwoods and Streambank

The lowland hardwoods and streambank areas within the valley were determined to provide more survival habitat for deer during severe winters than the lowland hardwoods beyond the valley. Above the valley, there could be a greater accumulation of snow which would hinder deer movement to and from isolated wooded areas. The streambank habitat, which is limited in the area, would provide a more diverse habitat along its edge. The 2.5 critical factor applied to the above habitats was based on the ratio of acres per animal between lowland and upland areas on the edge of the valley (taken from the monetary analysis).

(2) Wetlands

Since only one percent of the marsh areas remain in Norman County, the remaining wetlands are critical habitat for their associated fauna (refer to MLMIS, 1972). For this reason, type III and IV wetlands have a critical factor of 5. Type V wetlands have a critical factor of 4 because V's provide less brood habitat, less biomass per acre and wildlife cover than type III and IV wetlands.

(3) Other Habitat Types

All other habitat types were given a critical factor of one.

j. Comparison Ratio

The comparison ratios presented in Table 19 were determined by comparing the sum total of the comparison ratio criteria for Upland Hardwoods to the sum of each remaining habitat type (i.e., types II through XII). This resulted in a subtotal ratio with Upland Hardwoods having a base value of one. Upland Hardwoods were chosen as the standard for the habitat type comparison due to their uniformity in vegetation for all three study areas (i.e., Project, Downstream, and Faith areas). Once the subtotal ratio was determined for each habitat type, the final comparison ratio was then obtained by multiplying the subtotal ratio by the critical factor for each habitat type as identified in criteria III.E.1.i.(1), (2), and (3) (above).

TABLE 19. COMPARISON RATIOS

Habitat Type / Criteria	I UH	II - LH I.V.*	II - LH B.V.**	III O	IV UB	V LB	VI G	VII C	VIII SB	IX 6	X 2	XI 3 & 4	XII 5
1. Relative abundance	6	2	6	8	6	6	8	1	1	7	7	10	8
2. Vulnerability to adverse change	8	5	9	5	8	7	7	1	5	7	10	9	6
3. Food and cover capability	7	6	7	6	7	8	4	2	8	6	5	9	7
4. Reproductive value	8	7	8	8	8	7	5	1	8	5	7	10	8
5. Non-reproductive value	6	10	8	5	5	9	3	1	8	5	4	8	10
6. Meeting other environmental needs	7	8	5	8	4	5	3	0	9	4	3	9	8
7. Labor intensive Mgt. pot.	6	2	4	10	7	4	7	7	3	4	4	8	4
8. Capitol intensive Mgt. pot.	0	0	0	6	0	0	0	2	7	2	6	9	4
Subtotal :	48	40	47	56	45	46	37	15	49	40	46	72	55
Subtotal Ratio :	1	0.83	0.98	1.17	0.94	0.96	0.77	0.31	1.02	0.83	0.96	1.5	1.15
9. Critical factor	1	2.5	1	1	1	1	1	1	2.5	1	1	5	4
Comparison Ratio :	1	2.08	0.98	1.17	0.94	0.96	0.77	0.31	2.55	0.83	0.96	7.5	4.58

* In the valley

** Beyond the valley

F. Habitat Type Gain/Loss Evaluation

To further evaluate the selected compensation areas, it was necessary to compare habitat gains with habitat losses. Before the comparison could be made, the comparison ratios had to be applied.

In general, the habitat type gain/loss comparison was made on the basis of comparing habitat units. The resulting comparison reflects the original MPUV management level. More intensive wildlife management and future with project projections were not included in this evaluation. Therefore, the habitat type gain/loss evaluation was considered a baseline plan or projection for the compensation of terrestrial habitat losses in the project area. (Refer to Table 20.)

Table 20 indicates the results of the MPUV analysis, as modified by comparing unlike habitat types. Column (5)(difference between columns (1) and (4)) reflects the number of HU's not compensated by the management of the project and two compensation areas. Column (8) indicates HU's needed as a result of terrestrial habitat losses in the project area. Column (9) indicates HU's gained as a result of applying the management measures listed in Section II (MPUV analysis) in the project area and selected compensation areas.

G. Future With-Project (100-Year) Analysis

1. Methodology

In an effort to determine natural succession and project-induced habitat changes on the project area, a special form titled, "Changes in Acres," was developed. This form was used to determine changes in acreage and percent change over time for particularly hard to determine habitat types. The habitat types applied to the Changes in Acres form were the takeline area, recreation area A, and the floodpool (segments 1063-1085 and 1085-1104 m.s.l. elevations). Refer to Figure 2, in Section I for the location of the above-mentioned project planning segments.

The results from the Changes in Acres forms were transfered to the appropriate HEP form 3-1103. Other less difficult planning segments were annotated directly onto HEP form 3-1103.

The determination of habitat changes over time was basically an analysis of without project/without management (or minimal management) conditions. Habitat Unit Values were adjusted accordingly on the basis of assumed habitat quality changes.

As previously discussed in Section II.B (Terrestrial Habitat Evaluation), the HEP forms did not exactly agree with the computer printout results which are considered the accepted results. Likewise, the correspondence of the Changes in Acres data to form 3-1103 was not perfect due to format changes and corrected mathematical computations.

TABLE 20 TERRESTRIAL HABITAT UNIT GAIN/LOSS EVALUATION*

(1) HABITAT TYPE	(2) HU's Lost w/PROJECT	(3) HU's GAINED w/PROJECT	(4) HU'S GAINED FROM TABLE 18	(5) HU's NOT COMPENSATED	(6) [illegible]	(7) COMPARISON RATIO	(8) HU's NEEDED (5) x (7)	(9) HU'S GAINED (6) x (7)
1 Upland Hardwood	0	18,876	8,317	0	27,193	1.00	0	27,193
2a Lowland Hardwood (in valley)	25,009	0	2,647	22,362	0	2.08	46,513	0
2b Lowland Hardwood (beyond valley)	0	0	679	0	679	0.98	0	665
3 Oxbows	1,423	0	310	1,113	0	1.17	1,302	0
4 Upland Brush	0	17,606	646	0	18,252	0.94	0	17,157
5 Lowland Brush	0	1,704	186	0	1,890	0.96	0	1,814
6 Grassland	0	211	5,991	0	6,202	0.77	0	4,776
7 Cropland	29,126	0	16,602	12,524	0	0.31	3,882	0
8 Streambank	5,107	0	517	4,590	0	2.55	11,704	0
9 Type 6 Wetland	44	0	273	0	229	0.83	0	190
10 Type 2 Wetland	0	0	267	0	267	0.96	0	256
11 Type 3/4 Wetland	0	0	3,330	0	3,330	7.50	0	24,975
12 Type 5 Wetland	0	0	267	0	267	4.58	0	1,223
							63,401 TOTAL NEEDED	78,249 TOTAL GAINED

*The above table evaluates the losses (col. 2) and gains (col. 3) resulting from the Twin Valley Flood Control Project as compared to the gains (col. 4) from the mitigation areas (see Table 18). In-kind compensation results are shown in cols. 5 & 6. The comparison ratio shown in column 7 was used to compare one habitat type with another. Columns 8 & 9 are equivalent habitat units and therefore can be totaled and compared.

2. General Assumptions and Criteria

The following general assumptions and criteria were used to determine changes in terrestrial habitat between years 0 and 100:

a. Habitat loss was based on "professional judgment" with the use of flood duration-frequency curves, elevation maps and field notes.

b. The regeneration of grasses, forbs, shrubs and trees was considered when estimating habitat losses. Generally, the extent of habitat loss was reduced as a result of regeneration over a 100-year period.

c. Habitat losses were not determined beyond 100 years. Losses resulting from greater year floods are assumed rare, are difficult to measure, and exceed the normal life expectancy of the project.

d. The floodpool was divided into two segments for purpose of analysis. The segments were (1) the zone between the conservation pool (elevation 1063) and the floodpool (elevation 1085), and (2) the zone between 1085 and the top of the floodpool (elevation 1104). The elevation 1085 was selected as a "break point" because: (1) it is about one-half of the total floodpool elevation; (2) below 1085 all floods (5-100 year) occur, and above the 1085 only the 20-year floods or greater occur; and (3) stabilization of vegetation would begin to occur in about 20 years and would initially be most noticeable above 1085 because of the lessening impacts of fewer inundations of shorter duration (i.e., only 10 days or less duration for a 20-year flood above 1085).

e. It is assumed that no significant change in climate or land use will occur during the next 100 years.

f. The vegetation in the floodpool will develop into identifiable patterns in reasonably stable zones (or in an ecologically disclimax stage) in about 20 years.

H. Future Without Project Conditions

1. General

Water-resource planning methodologies require the projection and documentation of changes with the project over the 100-year period of analysis. These changes were detailed in the two previous sections. Also needed is a projection of future conditions without the project in the area of impact.

The without project conditions consider all changes, both natural succession and land/human-use changes, over the entire 100-year period of analysis. The impacts of the project (mitigable/compensatable/beneficial effects) are then calculated as the net difference between the with-project conditions and the without project conditions. Although the U.S. Fish and Wildlife Service does not agree with this method of analysis, they have indicated that the Corps method for determining impacts is acceptable because future conditions are considered to be near present conditions by year 100. This projection of no change or nearly no change in future conditions is based on the material discussed previously. This analysis applies to both terrestrial and aquatic habitats.

2. Methodology

Natural habitats were broken down into two categories - those with apparent potential to be fairly easily converted to agricultural use and those with little apparent potential. This was done for several reasons:

a. This breakdown provides base data for the without-project analysis. Trends in land use, etc., can be superimposed on these data in an effort to get the most realistic portrayal of likely changes over 100 years without the project.

b. The base data can be summarized and provided to the project Citizens Committee for their use in evaluating the desirability of alternate components of compensation plans.

c. Such a breakdown may suggest priorities for compensation, acquisition and preservation.

The natural habitats were broken down into the two categories by visual inspection of the terrestrial habitat type/topographic maps. For each area (project lands, Faith area, Downstream floodplain area, etc.) each kind of habitat was evaluated to determine the practicality with which it could be cleared or drained. Very small areas and fringes (i.e., wooded fringes of agricultural fields) were generally not considered clearable for practical purposes since the results would not appear to be worth the effort. Woody habitat types on steep slopes (i.e., Wild Rice Valley slopes) or areas of very irregular topography were also not considered to be clearable. Natural habitats within the Wild Rice floodplain were not considered subject to practical clearing and draining due to small size, irregular local topography, and/or limited access, although there are a few existing agricultural fields in the Wild Rice Valley. There also are several agricultural fields in various stages of abandon-

ment and natural succession. The trend, however, appears to be toward less agriculture in the valley. Some wetlands, because of their depth and topographic setting, were also not considered practical to drain. For example, some wetlands in the area are deep, landlocked depressions, and would require a mile of ditch or tile to depths of up to 30 feet to drain. Judgment was also made about other pertinent factors such as present and potential kinds of agriculture and how they affect clearing and draining.

For each habitat type in each area, a percentage was then estimated for the amount potentially convertible to agricultural use (Table 21). Table 22 shows the subsequent acreage breakdown.

3. Project Area

On the south side of the Wild Rice valley are two farms in sections 35 and 30 having cattle. However, only the farm running cattle in sections 20, 29, and 30 makes any significant use of the valley slopes and floodplain for grazing. There are also a few cropped fields in the floodplain on the south side.

On the north side of the valley are several farms which graze cattle in the fairly level upland woods and fields above the valley. Some grazing and cropping also occur within the takeline along Marsh Creek. Due to irregular topography and small acreages, the remaining natural habitat along Marsh Creek is considered to have no significant potential for clearing for practical purposes, although existing grazing of the grassland and wooded patches in that area seems likely to continue for some time.

The level uplands north of the valley, and between the dam site and CSAH 36, are considered to have potential for clearing, grazing, or cropping. This amounts to about 20 percent of the upland hardwood and 5 percent of the upland brush being potentially clearable.

Due to small size and to access problems for the area within the valley, no other areas were considered to have a practical potential for clearing for cropping purposes. The same assumption holds for clearing for grazing purposes, but this latter conclusion is based more on observations in the area. It seems that the grazed areas are small and irregular. Also, natural habitat within the valley and to the south is already grazed in places. There appears to be a fair balance between forage production and tree shelter and shade. Clearing appears to be minimal for fence maintenance.

Wetlands in the project area consist of a small perched type 6 wetland which could physically be drained, but such an effort does not seem worthwhile due to its location, small size, and peat soils. There are numerous small oxbows in the valley, but again drainage does not seem worthwhile.

The overall conclusion for the project area is that only two habitat types (upland hardwood and upland brush) on the level area above the valley on the north side seem practical to clear for agricultural purposes. Other sites are already in agricultural use or are not considered practical to convert to such use. Thus, few aquatic or terrestrial habitat changes are projected.

TABLE 21. EXISTING TERRESTRIAL HABITAT CONDITIONS - PROJECT AREA AND COMPENSATION ALTERNATIVE AREAS[1]

Habitat	Project Area	Faith Area	North Area	Marsh Creek Area	Downstream Area	Upstream Area
Upland Hardwood	931.7(80)	147.0(50)	20.0(20)	425.0(10)	202.0(100)	290.0(20)
Lowland Hardwood	1,038.3(100)	97.0(100)	15.0(20)	20.0(100)	257.0(100)	230.0(60)
Oxbows	45.2(100)	----------	----------	----------	11.0(100)	20.0(100)
Upland Brush	44.0(95)	----------	----------	10.0(10)	10.0(100)	----------
Lowland Brush	64.3(100)	----------	35.0(30)	10.0(100)	16.0(100)	10.0(60)
Grassland	217.0	616.0	75.0	85.0	53.0	10.0
Cropland	618.5	447.0	50.0	35.0	143.0	50.0
Streambank	184.2(100)	----------	----------	35.0(100)	46.0(100)	90.0(100)
Type 6 Wetland	8.0	39.0(100)	----------	----------	2.0(100)	----------
Type 2 Wetland	----------	43.0(100)	70.0(0)	----------	----------	----------
Type 3/4 Wetland	----------	319.0(100)	15.0(0)	----------	----------	----------
Type 5 Wetland	----------	43.0(100)	----------	----------	----------	----------
TOTAL ACRES	3,151.2	1,751.0	280.0	620.0	740.0	700.0

[1] Data are acres (and in parentheses the % of natural habitat area remaining after all potential draining and clearing losses are deducted).

TABLE 22. ACRES REMAINING AFTER ALL PRACTICAL, POTENTIAL CLEARING AND DRAINING HAS BEEN DEDUCTED[1]

Habitat	Project Area	Faith Area	North Area	Marsh Creek Area	Downstream Area	Upstream Area
Upland Hardwood	745.4	73.5	4.0	42.5	202.0	58.0
Lowland Hardwood	1,038.3	97.0	4.0	20.0	257.0	138.0
Oxbows	45.2	-----	----	----	11.0	20.0
Upland Brush	41.8	-----	----	1.0	10.0	-----
Lowland Brush	64.3	-----	10.5	10.0	16.0	6.0
Grassland	217.0	616.0	75.0	85.0	53.0	10.0
Cropland	618.5	447.0	50.0	35.0	143.0	50.0
Streambank	184.2	-----	----	35.0	46.0	90.0
Type 6 Wetland	8.0	39.0	----	----	2.0	-----
Type 2 Wetland	-------	43.0	0.0	----	-----	-----
Type 3/4 Wetland	-------	319.0	0.0	----	-----	-----
Type 5 Wetland	-------	43.0	----	----	-----	-----
New Cropland/Grassland (% of total in paren.)	143.5(4.5)	73.5(4.2)	137.5(49.1)	391.5(63.1)		328.0(46.9)
TOTAL ACRES	3,151.2	1,751.0	280.0	620.0	740.0	700.0

[1] Data are acres (and in parentheses the percent of natural habitat area remaining after all potential draining and clearing losses are deducted).

4. Potential Compensation Areas

a. Faith Area

Much of the Faith area is considered unsuited to any significant further clearing or draining because of its irregular topography. This is the case in much of the south and west part of the area. Some other areas are very flat but are not practical to drain because of the length and/or depth of ditching and tiling needed. This applies to areas near the Faith Wildlife Management Area and where scattered wetlands occur in irregular topography.

There are some small, scattered areas that could be converted to cropland. These areas amount to an estimated 30 percent of grassland and 50 percent of upland hardwoods. Grassland to cropland change was not included in Tables 9 and 10 which only considered natural to agricultural habitat changes. The rest of the area is already in cropland or pasture which is not expected to change.

b. Downstream Area

The Downstream area is grazed in some places, including within the valley. However, it includes only natural habitats usually within the valley or on the valley side slopes. The abutting lands are generally already cleared and grazed or in cropland, although some previously cleared areas are not now under active agricultural use.

The fairly flat natural habitat lands are essentially all within the valley and are small or are small parcels not belonging to the owner of the adjacent agricultural land. Therefore, no change is projected for both aquatic and terrestrial habitat conditions.

5. Discussion

After the potentially clearable and drainable areas were identified, foreseeable factors and trends which could influence habitat quality and quantity, and wildlife use of those habitats, were identified. Factors which influence recreational use but not habitat per se, such as changes in hunting seasons, were only considered in the monetary analysis. Applicable factors and trends include:

a. Public awareness of fish and wildlife values has increased in recent years, and it seems reasonable to assume that the trend would continue due to increasing scarcity of the fish and wildlife resource and increasing demand. Also, greater sensitivity toward the resource by younger generations should follow from increased environmental content in school curricula.

b. Public support of, and funding for, the various natural resource and environmental protection programs and agencies is on a general upswing, perhaps in response to the awareness discussed in the preceding paragraph.

c. The State Wildlife Management Plan is being revised. This revision would document the need for and expansion of existing wildlife programs, identify desirable plans, and thus encourage greater legislative support of natural resource programs.

d. In Minnesota and nationally, there is legislative and administrative concern for the fragmentation of natural resource functions. This is evidenced in proposed consolidation of agencies into a department of natural resources on the Federal level, and planned legislative hearings on efficiency and centralization of water resource functions on the State level. It would seem that after the identification and centralization of natural resource authority, legislative and administrative support would be greater.

e. Nonconsumptive uses of wildlife are increasing. Recreational uses are growing and tending toward uses which encourage greater wildlife contact and appreciation, ie., cross-country skiing, increased desire for physical fitness, the "energy crisis," and increased concern for environmental impact from structural alternatives. There is increased interest in having the non-consumptive public contribute funding toward wildlife programs. This could generate increased emphasis and support of fish and wildlife programs as will the continued creation and support of non-game wildlife programs by the natural resources agencies.

f. Greater leisure time, early retirement, and/or 4-day work weeks should encourage the trends and observations above.

g. No-tillage or minimum-tillage will be increasingly used in the project area. (See"'Age of the Plow' ending?," 25 January 1976, St. Paul Sunday Pioneer Press.) Pesticide testing and registration programs, plus trends toward increased target-specificity and shorter pesticide "lives," will reduce wildlife impacts.

h. Programs similar to the Soil Bank and Water Bank programs continue to be proposed and have some support. It is reasonable to assume the future will include such programs. This conclusion is based not only on considerations such as increased environmental concern and economic incentives and disincentives, but also on the increased awareness that nations with excess agricultural production cannot keep pace with a burgeoning world population. Future Soil Bank-type programs would logically include required seedings and/or longer retirements which would increase capability for wildlife habitat plus control of soil erosion and water quality.

i. Clearing for purposes of tilling (and in the future, possibly irrigation) continues in the project area, while clearing for grazing seems much less important, particularly considering past trends away from small herds. Much of the clearing seems to be in farmstead shelterbelts in conjunction with farm consolidation.

j. Grazing in the future has an equal chance of being one of the "rest" or "rotation" forms. This can be compared with present systems of maximum present gain which primarily benefit barren ground wildlife species such as killdeer but which act against game species.

k. Increased human population and/or activity in the future will increase the degree of governmental regulation, which is assumed to include equal or greater environmental concern. This follows from the "accepted" relationship that doubling a density more than doubles interactions among "neighbors."

l. The need for public acquisition or restrictive easement would increase. This would mostly involve marginal agricultural lands which form much of the project and compensation areas.

m. Increased wood and wood product needs in the future, coupled with increased "set-asides" in wood fiber production areas for recreation and other purposes, would create an incentive to retain wooded areas in the project area, particularly as markets and usage technology improve.

n. Hobby farmers and absentee landowners will balance to some degree the general trend toward large agri-business activities in the area. Further, the wooded Wild Rice valley in this reach offers more opportunity than most areas in the region for those who seek a wooded retreat not necessarily near a lake. This sort of acquisition and passive management should increase wildlife values over those resulting from more intensive economic uses.

o. Needs for downstream flood damage reduction will promote the development of upstream ponding areas. This would probably degrade wildlife values of such lands. The lands, however, could be dedicated to a public use, with fish and wildlife concerns probably increasing as outlined, above.

p. Section 208 (P.L. 92-500) planning for non-point pollution control would probably benefit fish and wildlife under any recommended alternative.

q. Land-use controls not reserved by the State legally remain the province of local governments. However, the State imposes minimum standards and/or substitutes State guidelines if local governments do not act accordingly. The result is greater environmental protection concerning floodplain management and shoreline zoning.

6. Conclusions

Almost all trends in the areas of legislation, education, leisure time, governmental regulation, etc., point to a future which would preserve and/or restore wildlife habitat. Some losses would occur, but these would be balanced to a large extent by benefits from erosion control programs, etc. Meanwhile, clearing and draining by some landowners would continue. The future without project conditions, therefore, are assumed to be 10 percent of the identified practical clearing and draining occurring by the year 1990, with a return to at least present (or base) conditions by year 100 of the analysis.

It should be noted that impacts due to some land uses, such as hobby farms and cottage development in wooded areas, would not be precluded by acquisition for compensation because the developer would still have the funds and interest in cottage development. If the land at Twin Valley were acquired for compensation, the developer would merely go elsewhere, and the overall level of impact would be the same. Hence, these categories of land use are not applied for or against compensation in the calculations.

I. Indeterminable Effects

The preceding analysis does not take into consideration some unanticipated and recognizable effects as well as effects dependent on future decisions by others. These effects have the potential to increase the number of habitat units lost as a result of project activities and decrease those habitat units gained through land acquisition and management. The impact categories which have not as yet been accounted for are described as follows:

1. Fish and Wildlife Management

The science of fish and wildlife management still retains many of the characteristics of an art. There is necessarily some uncertainty as to the response of fish and wildlife populations to habitat management. While, for example, little information is available on the exact timing of implementation of management practices, effects of size and positioning of various structures, and the degree to which each management practice should be employed. There is even greater uncertainty as to the extent, nature, and impact of reservoir shoreline slumping, erosion, and habitat damage due to flooding. Slumping and erosion were not considered in the HU impact analysis. The rest of these problems were considered as best as possible in both the HU and monetary analyses, and an estimate was made of the beneficial effects of management, even though there are little data to substantiate the effectiveness of management under the periodic stress of project operation.

2. Flood Control

Estimates of damage due to floodwater storage were based on the reservoir operating plan presented in DM No. 1, Hydrology and Hydraulic Analysis, dated January 1975. Ongoing studies include such things as detailed downstream channel capacity determinations, which could result in greatly restricted reservoir outflows, which would result in greater habitat damages in the pool area than have been assumed. Similarily, if a greater degree of control were sought over the more frequent floods, damages would be greater.

3. Water Quality Investigations

Future water quality investigations will address the possibility of determining an optimum conservation pool elevation for water quality based on nutrient loading and flow-through relationships. If the pool elevation changes significantly, the analysis of HU's lost and gained in the conservation and flood pools could change appreciably. The water quality investigations could also affect the type and amount of fishery compensation needs.

J. Aquatic Habitat Compensation

The Twin Valley aquatic compensation plan is based on the habitat unit analysis and is designed to replace aquatic losses in the project area by improving the aquatic habitat in the Downstream compensation area. The tri-agency team judged the compensation plan to be acceptable even though 100 percent compensation of the existing fishery resources lost with the project is not feasible. The recommended plan is expected to provide approximately 30 percent of the necessary compensation.

The habitat unit analysis is designed to compensate losses in kind and to treat project gains as concomitant benefits. To fully compensate losses in kind, a length of stream estimated at 2 to 3 times the length of the proposed Downstream area would have to be acquired. Habitat improvement measures such as bank stabilization and instream structures would be needed along with protection of the adjacent riverine corridor to provide habitat for benthic organisms, holding cover and spawning substrate to compensate for losses in kind. The additional miles of river, riparian lands, and structural measures needed were judged impractical because of the high (excessive) amount of terrestrial HU's that would result to satisfy the aquatic compensation requirements. The compensation of aquatic stream losses further downstream from the Project area was also judged impractical because it was preferable to keep fish and wildlife mitigation measures in the vicinity of the project impacts. Thus, the remaining aquatic compensation requirements were judged to be unmitigable.

IV. SUMMARY OF COMPENSATION PLAN

The Fish and Wildlife Compensation Plan contains a combination of land acquisition and habitat management.

A. Acquisition

1. General

Two areas (Faith and Downstream) were selected from the five alternatives considered for acquisition. (Refer to Figure 9.) These areas would adequately replace fish and wildlife losses expected to result from the proposed project. In the selection of these areas, every effort was made to ensure an accurate and reasonable evaluation of future with project habitat losses and needs, and future without project habitat changes.

The selection of the two compensation areas was based on a number of factors including the area's ability to satisfy compensation needs (acquisition and management) and minimal costs compared to fish and wildlife benefits gained. The selected areas would be the easiest to acquire and least expensive to manage. In addition, large cropland areas, farmsteads, and homesites would be avoided as much as possible.

2. Faith Area

This area consists of a total of 1,750 acres located about 1 mile south of the project area and adjacent to the existing 380-acre Faith State Wildlife Management Area (WMA). The area consists primarily of low to high value wildlife habitat and small plots of marginal agricultural lands. With management, the area could be developed into highly productive wildlife habitat that would complement and improve on the local and regional use and value of the existing Faith WMA.

The Faith area would provide a large portion of the terrestrial habitat compensation needs. A large variety of wildlife species would benefit from the acquisition of this area, including deer, upland game birds and mammals, mink, muskrat, beaver, and a variety of water-oriented species.

3. Downstream Area

The Downstream area consists of about 740 acres of floodplain habitat extending from the downstream project take-line to the County-owned recreation area adjacent to the Heiberg Dam, a distance of approximately 2-1/2 miles (Refer to Figure 9).

Existing habitat consists primarily of riparian woodlands, brush, oxbows, and several small agricultural fields.

The Downstream area would provide terrestrial as well as aquatic habitat compensation benefits. Acquisition of the land and management would provide the remaining benefits needed to satisfy fish and wildlife compensation needs.

Wildlife species which would benefit include deer, raccoon, squirrel, beaver, mink, wood duck, and a variety of other riparian species. The protection and management of the Wild Rice River would improve the habitat for northern pike, invertebrates, and other aquatic organisms. Additional recreation benefits would result from connecting the Heiberg area with the recreation areas and facilities of the project area.

Future development in the Downstream area would probably occur due to the presence of the dam and greater flood control protection. The Downstream landowners would have more monies available for development through reduced flood losses or through the sale of unmanageable land for hobby farm and cottage developments. Fee title acquisition in the Downstream area would preclude future development, thus preventing further disruption of the terrestrial and aquatic habitats and reducing future flood control costs and associated adverse health, safety, and economic effects.

B. Plan Synthesis and Integration

Based on HEP (Section II) and subsequent analysis in Section III, HU needs and HU gains were compared for the acquisition of the Faith and Downstream floodplain compensation areas. The management practices which could be employed in the project area, and compensation areas were also discussed.

The management measures, described in this Section, were derived primarily from the MPUV analysis (Section III), with the addition of several larger capital investment measures.

Table 23 compares the final adjusted HU totals derived from the HEP process.

TABLE 23. FINAL COMPARISON OF HEP RESULTS

	HU Losses	HU Gains
Terrestrial	63,401 1/	78,249 2/
Aquatic	3,880 3/	1,280 4/
Subtotal	67,281	79,529
Additional HU's Lost	+5,550 5/	
HU's Foregone		-1,357 5/
Total	72,831	78,172

* *

1/ Refer to Table 21.
2/ Refer to Table 21.
3/ Refer to Section II.C.
4/ Gains resulting from major capital investment measures which provide approximately 33% of the necessary compensation.
5/ Design Memorandum No. 2, Phase II - General Project Design (dated December 1978) indicated that an additional 200 acres would be lost in the conservation and flood pool areas of the project due to construction activities. The dam site and relocation of CSAH 36 would account for a majority of this acreage. Preliminary estimates indicate that approximately an additional 5,550 HU's and approximately 1,357 MPU's would be lost from the project area. These HU's were not accounted for in the previous HEP analysis.

After applying the HU's lost from construction activities to the data in Table 23 it is apparent that the compensation needs of the project have been overestimated. In consultation with the FWS and the MDNR, the Corps has determined that approximately 320 acres could be removed from the compensation plan to balance the gain/loss columns (see the FWS and MDNR letters, Exhibits 1 and 2, respectively). It was also decided that the acreage should be removed from the Downstream area since both agencies would prefer to obtain the Faith area as one large managable unit. Minus the above acreage, the Downstream area would retain approximately 420 acres for compensation purposes. The actual location of the area to be acquired will be discussed during future meetings with the FWS and MDNR.

C. Fish and Wildlife Management

1. Introduction

Under the Habitat Evaluation Procedures, intensive management would lessen the acreage needed for acquisition. Fish and Wildlife management recommendations are therefore based on what measures could reasonably be implemented in the general area. All of the measures are related to the calculated habitat units of compensation gained.

Management of the reservoir fishery is recommended but should not be weighed for or against compensation needs since the reservoir is considered a concomitant benefit to fish and wildlife as a result of the project. Management of the reservoir, however, should be considered as a separate project feature relating to fishing, other recreational benefits, and flood control.

2. General Administrative/Management Measures

Implementation of specific fish and wildlife compensation plan measures would require or could be greatly enhanced by the following general administrative and management measures:

a. A cooperative agreement should be developed between the Corps of Engineers and the Minnesota Department of Natural Resources (MDNR) which would permit the MDNR to manage the Project lands, Faith area, and Downstream area for fish and wildlife purposes in accordance with the Corps master plans. The agreement between the MDNR and the Corps of Engineers should follow the prescribed plan as closely as possible. However, as management methods and cost estimates are refined, some departures from the plan are expected. The efficiency and potential public value from managing the Faith area could best be accomplished if the lands were managed by the MDNR in conjunction with the existing 380-acre Faith Wildlife Management Area. To offset the financial responsibility of managing these lands, the Corps of Engineers should consider procedures for providing funds to accomplish annual maintenance of project-related fish and wildlife compensation measures. The proposed managing agency (MDNR) views the receipt of operation and maintenance funds as an integral and required part of the overall development of the fish and wildlife compensation plan, as specified in this document. Without such funding, it is unlikely that the MDNR could implement many of the active management measures identified in the following pages, thus creating a situation where the MPU's needed to offset project losses would not be achieved. In such a situation, the amount of land needed for mitigation purposes would be greater than the 2,170 acres presently being requested. The actual acreage would be determined through a re-evaluation of the MPU's that could be obtained through a more passive management program.

b. The Corps of Engineers should investigate the possibility of providing payments to the county for all lands removed from the tax roll.

c. The Faith area would be open to hunting and trapping and other uses permitted by State laws and regulations appropriate to State wildlife management areas.

d. The Corps Recreation Master Plan would indicate the appropriate public uses permitted on the project lands. Fishing, hunting, trapping, hiking, nature study, photography, and environmental education would be appropriate uses in the project area.

e. Some recreational activities such as hunting and trapping might be restricted in Recreational Areas A and B.

f. Install fish and wildlife management-related signs, develop project leaflets, and construct a visitor contact station in the recreation area. The visitor contact station and project leaflets would indicate that fish and wildlife is a project objective and would describe the type and value of the compensation measures.

g. Develop guidelines for a cooperative share-crop farming program with the previous landowners, adjacent landowners, and other interested parties. The share-crop program would benefit deer, upland game, waterfowl and other wildlife species. Dense nesting cover (DNC) could also be planted by this means.

h. The water level management plan for conservation/flood pool would consider measures to promote rooted aquatic vegetation in the upper pool area for waterfowl, furbearers, and northern pike production.

D. Description of Habitat Improvement Measures

1. Create Forest Openings

The forest openings would be 1 to 2 acres in size (one opening per 10 acres of habitat) to encourage new tree, shrub, and forb growth for deer, ruffed grouse, red fox, and a variety of other wildlife species. Rotating the cutting would be most desirable. Several half-acre openings in ash and aspen stands on the south side of oxbows would encourage new tree growth for beaver, frogs, rodents, and a variety of songbirds. This measure would be accomplished in the upper end of the project area.

2. Retain Dead Trees and Snags

Dead trees and old snags would be retained in upland portions of the Project and Faith areas. This would benefit woodpeckers, wood ducks, squirrels, bats, raccoon, hawks, and owls.

3. Seed Trails with Grasses and Legumes

Construction trails and old roads would be disked and seeded with a mixture of grasses and legumes. Trails serve as important travel lanes for deer, ruffed grouse, red fox, skunk and a variety of other wildlife species. The grasses and legumes also provide food for many species. This measure would apply to the Project, Faith, and Downstream areas.

4. Eliminate or Reduce Grazing

This would encourage plant re-growth and increase the variety of plant species present which would benefit most species of wildlife. This measure would apply to the Project and Faith areas primarily.

5. Plug Oxbow Outlets

Riprapped earthen plugs would prevent the drainage of old oxbows or divert controlled flows from gullies, benefiting beaver, wood duck, great blue heron, raccoon, mink, frogs, and turtles. This measure would apply to the Project area.

6. Create Rock and Brush Piles

As a result of construction activities in the Project area, piles of rocks and brush 5 to 10 feet in diameter and 3 to 5 feet high would be scattered throughout the upper and higher portions of the flood pool and in upland brush areas. This measure would benefit weasel, skunk, cottontail, woodchuck, and many species of songbirds and rodents.

7. Plant Trees and Shrubs

Shrubs and shrubby tree species such as dogwood and Russian olive would be planted on the borders of upland brush areas in the Project and Faith areas. A variety of native tree species such as basswood, oak, wild plum, chokecherry, maple, and ash would be planted in or adjacent to the recreation area. Small groves of conifers could also be planted for wintering deer and pheasant cover. The trees and shrubs could be planted in blocks or strips.

8. Trim and Mow Brush

Considerable willow and alder growth could occur in the flood portion of the Project area. Large solid stands would have reduced value to wildlife. Mowing or burning of larger stands would occur where appropriate. Some willow and alder control may also be needed on the Faith area. This measure would benefit waterfowl, deer, furbearers, and northern pike. A tractor-mower is a practical method to control brush.

9. Share-Crop Farming Agreements

A cooperating farmer would receive an annual lease for a particular field. The managing agency would receive payment for the lease by receiving a share of the crop. The crop could remain standing over the fall and winter months. The farm operator may be allowed to return and harvest the remaining crop in the spring. This measure would benefit deer, pheasant, waterfowl, and other species. Most of these agreements would occur on existing croplands acquired near the take-line in the Project and Faith areas. This agreement would benefit both the farmer and wildlife. This program could be administered by either the Corps of Engineers or Minnesota DNR.

10. Backslope Eroded Banks

Severely eroded banks along the Wild Rice River in the Project and Downstream areas would be riprapped or gabion-lined from the toe of the bank to approximately eight feet up the bank. This measure would reduce the silt load in the river, protect the existing aquatic habitat, and improve water quality and the aesthetic attributes of the area.

11. Erect Wood Duck Boxes

Wood ducks could substantially increase in the Project and Faith areas if nesting structures were available. The potential success of this measure is also increased by the creation of the reservoir and the plugged wetlands in the Faith area which provides additional waterfowl brood rearing habitat. The boxes could be purchased or installed as a project of a local conservation organization, club or school. The Minnesota DNR could assist in determining locations to install the wood duck boxes.

12. Conduct Periodic Burning

Native and domestic grassland habitat would be maintained in the Project and Faith areas if periodic burning was accomplished. This is a common habitat management practice by the Minnesota DNR and U.S. Fish and Wildlife Service in western Minnesota. Trained fire crews usually accomplish the burn. Detailed procedures would be obtained from the Minnesota DNR.

13. Encourage Soil and Water Conservation in the Watershed

This measure is included in the project to protect the flood control and recreational value of the reservoir and water quality of the Wild Rice River system. Agencies such as the Soil Conservation Service and Wild Rice Watershed District should continue to sponsor and initiate projects which conserve soil and water resources. This measure would not involve any active Corps of Engineers participation outside of the project and compensation areas.

14. Plug Wetland Outlets

Numerous existing ditches occur in the Faith area as a result of past drainage efforts. Plugging ditches with earth plugs and diverting water flows would substantially improve several hundred acres of marginal wetlands. Type 2-3 wetlands would be changed to Type 3-4 wetlands. No flooding would be allowed to occur on or to affect adjacent private lands. This measure would benefit waterfowl, pheasant, mink, muskrat, beaver, heron, and a variety of other water-oriented wildlife species.

15. Excavate Potholes

Several wetlands in the Faith area could be substantially improved for breeding and migrating waterfowl if more open water areas existed. Potholes would be created by dozer or dragline. The Minnesota DNR would assist in determining where and how to accomplish this measure. This measure would benefit waterfowl and other water-oriented wildlife species.

16. Install Waterfowl Nesting/Loafing Sites

Waterfowl nesting and loafing sites would consist of logs, small earth mounds, and artificial nesting structures. These measures would be installed in the Faith area and would primarily benefit waterfowl.

17. Divert Ditch Flows

Numerous existing ditches occur in the Faith area as a result of past drainage efforts. Diverting water flows and plugging ditches would substantially improve several hundred acres of marginal wetlands. Type 2-3 wetlands would be changed to Type 3-4 wetlands. Earthen ditch plugs, scraped or drag-lined work would accomplish this effort. This measure would benefit waterfowl and other water-oriented wildlife species.

18. Create Subimpoundments for Fish and Wildlife

Gabion-type subimpoundments could be constructed in the upstream area and on the smaller tributary streams at the project area. The subimpoundments would primarily benefit northern pike production but would also benefit waterfowl, muskrat, beaver, mink, and occasionally walleye.

19. In-Stream Fishery Improvement Structures

Gabion-type structures 1 to 3 feet high would extend across the river, bank to bank (approximately 60 feet wide) in the Downstream area. The flow would be funneled toward the center, and drop to form a scour hole below the structure. The scour holes would encourage the survival of game and sport fish species such as northern pike, walleye, and rock bass.

20. Drop Structures to Control Erosion

Concrete erosion-control drop structures would be constructed in gullies and steep-gradient road ditches which enter the Project area. This measure would reduce sediment accumulation in the reservoir and maintain existing water quality.

E. Costs

The estimated costs of proposed fish and wildlife compensation measures are based on the best information available at this time. The costs include allowances for contingencies (15 percent), engineering, and design (14 percent), and supervision and administration (4.5 percent inspection and 10.5 percent overhead). Real estate costs are based on reconnaissance of the project and compensation areas, county assessment records, and recently recorded sales, and include acquisition expenses and an allowance for contingencies. Average annual charges are based on an interest rate of 7-1/8 percent and a project life of 100 years.

A summary of first costs and average annual charges for the fish and wildlife compensation plan (land acquisition and implementation of habitat management and improvement measures) is presented in Table 24. A detailed estimate of first costs is presented in Tables 25 and 26. An estimate of annual operation and maintenance cost is presented in Table 27.

1. Estimated First Costs

The detailed estimate of first costs for the fish and wildlife compensation plan recommended in this report is given in the following table with cost shown based on October 1979 price levels. The estimated cost of lands is based on appraisal data obtained from field surveys, county assessment records and recently recorded sales. The value per acre given in Table 25 is the average cost per acre of cropland in Norman County, Minnesota. It is expected that the value of other lands such as woodland, brushland, grassland, wetland, etc., would be somewhat lower.

2. Estimated Annual Charges

Annual charges for the recommended fish and wildlife compensation plan are based on an annual interest rate of 7 1/8 percent and on an amortization period of 100 years. Operation and maintenance costs are based on data received from the Fish and Wildlife Service and Minnesota Department of Natural Resources. Estimates of the average annual operation, maintenance, and replacement costs are shown in Table 27.

TABLE 24. COST SUMMARY FOR FISH AND WILDLIFE COMPENSATION PLAN

Compensation areas	Quantity (acres)	First costs: Land acquisition[2]	First costs: Management & improvement measures[3]	First costs: Total	Average annual charges: Interest and amortization	Average annual charges: Operation, maintenance and replacement	Average annual charges: Total
Project Area[1]	-	-	$116,000	$ 116,000	$ 8,300	$ 9,900	$18,200
Faith Area	1,750	$1,359,600	$231,800	$1,591,400	$113,500	$ 13,400	$126,900
Downstream Area	420	$ 318,900	$202,200	$ 521,100	$37,200	$ 9,400	$46,600
Total	2,170	$1,678,500	$550,000	$2,122,500	$159,000	$ 32,700	$191,700

(1) Certain fish and wildlife measures will be applied to project lands. Acquisition of these lands is a project cost item, not a fish and wildlife compensation cost item.

(2) Includes Public Law 92-646, damages, contingencies, and acquisition costs (also see Table 25).

(3) Includes engineering, design, supervision, and administration.

TABLE 25. DETAILED ESTIMATE OF FIRST COSTS FOR LAND ACQUISITION, TWIN VALLEY LAKE, WILD RICE RIVER, MINNESOTA PROJECT.

Item	Unit	Quantity	Unit Cost	Total First Cost
Direct first costs				
Land acquisition				
Lands, fee title	Estimated Acreage	1,750	$ 570.00	$ 997,500
Lands, fee title	Estimated Acreage	420	$ 570.00	$ 239,400
Public Law 92-646				$ 116,700
Damages				$ 46,700
Contingencies				$ 147,900
Acquisition costs				$ 130,300
Total lands and damages				$1,678,500

TABLE 26

DETAILED ESTIMATE OF FIRST COSTS FOR FISH AND WILDLIFE COMPENSATION, TWIN VALLEY LAKE, WILD RICE RIVER, MINNESOTA

Item	Unit	Quantity	Unit cost	Total first cost
Habitat management and improvement measures (1)				
Project Area				
Create forest openings	Acre	43	$ 600.00	$ 25,800
Seed trails with grasses/legumes	Mile	2.75	500.00	$ 1,375
Plug oxbow outlets (8 each)	Job	Sum		$ 2,900
Plant trees and shrubs	Acre	5	600.00	$ 3,000
Trim/mow brush	Acre	10	250.00	2,500
Backslope eroded banks	SF	1,000	5.00	5,000
Erect wood duck boxes	EA	20	60.00	1,200
Conduct periodic burning	Acre	33	80.00	2,640
Subimpoundments for waterfowl, furbearers, and northern pike	EA	4	5,800.00	23,200
Drop structures	EA	2	7,000.00	14,000
Contingencies				12,385
Total Project Area measures				$ 94,000
Faith Area				
Create forest openings	Acre	38	600.00	$ 22,800
Seed trails with grasses/legumes	Mile	0.5	500.00	250
Plug wetland outlets (6 each)	Job	Sum		8,750
Trim/mow brush	Acre	30	120.00	3,600
Erect wood duck boxes	EA	5	60.00	300
Conduct periodic burning	Acre	55	80.00	4,400
Excavate potholes	EA	10	175.00	1,750
Install waterfowl nesting/loafing sites	EA	12	250.00	3,000
Divert ditch flows	Mile	0.75	8,200.00	6,150
Plant trees and shrubs	Acre	5	600.00	3,000
Install fencing and signs	Mile	10	10,500.00	105,000
Provide parking areas	EA	3	1,200.00	3,600
Contingencies				25,400
Total Faith Area measures				188,000

TABLE 26 (continued)

DETAILED ESTIMATE OF FIRST COSTS FOR FISH AND WILDLIFE COMPENSATION, TWIN VALLEY LAKE, WILD RICE RIVER, MINNESOTA PROJECT

Item	Unit	Quantity	Unit cost	Total first cost
Downstream Area				
Seed trails with grasses/ legumes	Mile	0.5	$ 500.00	$ 250.00
Backslope eroded banks	SF	6,000	5.00	30,000.00
Erect wood duck boxes	EA	5	60.00	300.00
Construct instream fishery improvement structures	EA	4	4,100.00	16,400.00
Install fencing and signs	Mile	8	11,700.00	93,600.00
Provide parking area	EA	1	1,200.00	1,200.00
Contingencies				21,250.00
Total Downstream Area measures				163,000.00
Total direct first costs				2,123,500.00
Indirect first costs				
Engineering and design				62,000.00
Supervision and administration				43,000.00
Total indirect first costs				105,000.00
Total first costs				$2,228,500.00

(1) Certain measures which can be accomplished concurrently have been grouped together. For example, costs for creating forest openings also include costs for creating rock and brush piles.

TABLE 27

ESTIMATE OF ANNUAL OPERATION, MAINTENANCE, AND REPLACEMENT COSTS.

Item	Annual Cost
Replacement of habitat management and improvement measures	
Project Area	$ 2,300
Faith Area	5,800
Downstream Area	4,700
Operation and maintenance	
Project Area	7,600
Faith Area	7,600
Downstream Area	4,700
Total	$32,700

V. MONETARY EVALUATION

A. Methodology

Corps of Engineers policy requires at least one other form of analysis when the Fish and Wildlife Service Habitat Evaluation Procedures are used in determining project-induced impacts on existing fish and wildlife resources. Although the exact method is not specified, this analysis should follow one of the traditional approaches. Hence, the monetary evaluation presented here focuses on the human use of the fish and wildlife resources (i.e., on a basis of supply and demand) in order to determine the monetary value of project impacts. The results of the monetary evaluation provide a means to compare the results obtained from the "habitat unit value" analysis. This information could also be used in the cost allocation process and in justifying fish and wildlife enhancement features. A series of calculations is made to determine the present and projected use of the project area as well as the present and projected productive potential of the habitat to satisfy the demand for recreational and commercial uses. This information is then used to develop supply and demand curves for calculating average annual use and average annual equivalent monetary values.

The evaluation team considered acreage of primary habitat types, maximum harvest percentage, man-day effort per unit of harvest, and monetary value for each type of use in developing the necessary supply and demand display.

Separate calculations were made for each planning area segment of the project area. This allows the comparison of existing biological productivity by segment for each set of project conditions. Analysis by planning segments also assisted the evaluation team in making judgments on how each segment would change under the future "without project" and "with project" conditions.

The general procedures for estimating man-days and monetary values was as follows:

Step 1: Estimate the present potential (present supply) of the habitat and determine the monetary values associated with the corresponding level of use in terms of man-days and dollars. These estimates provided the base reference points in preparing supply curves for the period of analysis and are based on resource information obtained from Federal Aid reports, State fish and wildlife plans, National Survey of Fishing and Hunting, field surveys, and personal knowledge of the project area.

Step 2: Estimate the future potential of the habitat to provide for use of the resource at one or more future (target) years over the period of analysis (life of the project) and determine the monetary values associated with these uses. These estimates have been prepared for "without project" conditions and for each alternative plan. The information thus developed provided additional reference points for use in preparing supply curves

Step 3: Estimate present use (present demand) and respective monetary values associated with the project area for each species to be evaluated. These estimates provided the base reference points in preparing the demand curve for the period of analysis The most reliable information available was used in estimating present demand. This varied from obtaining actual use data from surveys or field investigations, to making comparison estimates or prorated estimates of total State use.

Step 4: Estimate future demand by target year and the respective monetary values for the project area. Information thus developed provided additional reference points needed to prepare the demand graphs for the period of analysis.

An estimate of present and future demand for each type of use was obtained by using present and projected population data; hunting, fishing, and trapping license sales; survey data concerning trips per season and preference of outdoor recreationists to participate in these activities; and fish and wildlife resources available.

The objective of this step was to obtain the best estimate of future man-day use that could be provided by the primary habi under resource changes expected at the target years and the associated monetary value of that use. These calculations considered projected land use and ecosystem changes reflected in terms of the primary habitat available and wildlife densities. These data were then combined with known biological data or the best estimate of each biological factor involved to calculate the estimated potential man-days and value.

If no land-use or water quality changes, introduction of wildlife or fish species, or changes in hunting or fishing preference and harvest data were anticipated in the future, the predicted use at any of the target years would be the same as the present use data developed in Step 3.

Step 5: 'repare supply and demand graphs for each species being evaluated under the "without project" conditions and for each alternative plan, from the information developed in Steps 1 through 4. Separate supply and demand graphs were constructed for man-days use and for monetary value.

Using the area of the graph prepared for Step 5 that falls under both the supply and the demand curve, the following was computed for each species being evaluated:

Step 6: The average annual use in man-days for "without project" conditions and for each alternative plan, over the life of the project.

Step 7: The average annual equivalent value for "without project" conditions and each alternative plan, over the life of the project.

Step 8: Summarize the results of these analyses and display.

B. Terrestrial Evaluation

This monetary analysis is based on wildlife population indices and estimates and is therefore quite different in approach from a recreational analysis based on recreational supply and demand. The monetary analysis is instead a hybrid between the user-day and wildlife population approaches. The data may be used as one type of index to wildlife population changes expected to occur with and without the project.

The monetary analysis is directed only at project lands and does not include mitigation areas or management of project lands for wildlife. It therefore is an estimate of the need for mitigation, although reliance is placed on the more satisfactory HUV analysis for justification of mitigation. Four planning segments were used in the terrestrial wildlife monetary evaluation: Conservation Pool (CP), Flood Pool (FP), Flood Pool Through Take Line (FP→TL), and Structures and Spillway (ST & SP).

For an analysis of acquisition and management of the compensation areas, refer to Sections II and III.

The terrestrial summary of the economic impact of the Twin Valley project indicates an average annual loss in worth of $6,854 and an average annual equivalent loss of $7,422.

C. Aquatic Evaluation

The Twin Valley aquatic monetary analysis is based on the "Evaluation of Stream Characteristics and Fish Populations of the Wild Rice River Near the Proposed Twin Valley Reservoir, Minnesota." The study was conducted in June of 1976 by the Minnesota DNR under contract with the U.S. Army Corps of Engineers.

The study determined the existing (1976) acreage of five segments, above Flood Pool (AFP), Flood Pool (FP), Conservation Pool (CP), Tailwaters 1 (TW-1), and Tailwaters 2 (TW-2). Standing crops of the five main fish species were calculated. These five species were used for the monetary analysis: to determine the percent catchable size, golden, shorthead, and silver redhorse 12" or larger, rock bass 6" or larger, and northern pike 18" or larger were used. Sustained harvest rates were based on available MDNR information. The catch per man-day was estimated based on the existing population, average size of fish, and estimated fishing pressure.

A 100 percent loss is assumed for the existing stream fishery in the conservation pool. A 30 percent loss to the existing stream fishery is assumed in the flood pool during the life of the project due to silt deposition and longer and more frequent inundations. In the above flood pool segment some negative impacts are expected due to siltation and degradation of river habitat by carp. However, it was assumed that these impacts would be offset by Section 208 water quality planning and improved watershed management practices during the life of the project.

The Tailwaters 1 and 2 areas would be severely affected during the construction phase of the project. However, a return to normal water conditions was assumed to occur after completion of the project and no negative impacts were calculated.

The 1973 Principles and Standards (P & S) of the Water Resources Council established a range of $0.75 to $2.25 per general recreation day. P & S includes river fishing as generalized recreation, so $1.50 was used per man-day of fishing for the redhorse species and rock bass. Northern pike fishing was valued at $2.25 per man-day in the analysis.

The aquatic summary of the economic impact of the Twin Valley project indicates an average annual loss in worth of $426 and an average annual equivalent loss of $398.

The monetary analysis does not adequately portray the value of the fishery. In the "Monetary Values of Fish" established by the North Central Division of the American Fisheries Society, redhorse species are valued at $.40/pound, rock bass at $3.00/pound, and northern pike at $4.00/pound. Applying these values per pound to the available pounds of fish lost from the annual harvest in the conservation and flood pool, an annual loss of $656 is obtained. The initial loss of the catchable crop in the conservation pool is $1,999.

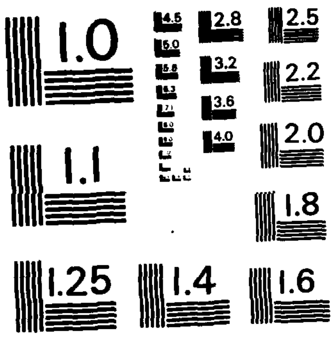
Neither the monetary analysis nor the monetary value per pound of fish (preceding paragraph) include an economic value for other species of fish in the river because they were not abundant at the time of the survey. There is no information available to indicate the value of the walleye runs up the river in spring, although it is known that the walleye are commonly found in the project area of the Wild Rice River in the spring. In addition, it is not known how representative of normal conditions the 1976 fish population study was since it was a one-time survey and occurred during a severe drought year.

Fishing demand was assumed to be greater in the project area than the available supply indicated on HEP form 3-1109. This is due to the fact that the analysis did not include all species of fish found in the project area, to lack of data on the seasonal abundance of fish and the annual amount of fishing pressure, and to low interest in stream fishing from the local community.

Another important item which cannot be included in the monetary analysis is the loss of a free-flowing stream as a result of the project. It is impossible to determine the extent of this impact on the stream fishery.

AD-A139 349 FLOOD CONTROL TWIN VALLEY LAKE WILD RICE RIVER NORMAN COUNTY MINNESOTA PA..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT JUN 80 2/2

UNCLASSIFIED F/G 6/6 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

D. Discussion

Although some incidental fishery benefits are identified elsewhere in this report, they are not cancelled against terrestrial or aquatic wildlife losses. This is in keeping with present Fish and Wildlife Service HEP procedures and a Corps of Engineers policy which states that, "One type of fish and wildlife benefit will not be used as an offset for another type of fish and wildlife damage, nor will only the net effect be shown" (Corps ER 1105-2-129, paragraph 11c, dated 15 August 1973).

From the terrestrial monetary evaluation, another method could be derived for determining terrestrial compensation needs. This approach would involve dividing the loss estimates by acres needed to support a hunter-day. The possible resource design standards are:

Big Game

Iowa SCORP: 15-40 acres needed for 1 hunter-day.
Wisconsin SCORP: 64 acres needed for 1 hunter-day.
GREAT I[1]: 40 acres needed for 1 hunter-day.

Upland Game

Iowa SCORP: 5-100 acres needed for 1 hunter-day.
Wisconsin SCORP: 8-10 acres needed for 1 hunter-day.
GREAT I[1]: 10 acres needed for 1 hunter-day.

The population figures indicated for deer are based on the existing deer population within 10 miles, north and south, of the project area, or 140 square miles. The Wild Rice River Valley is the major deer wintering area in Norman County. During severe winters, the valley is critical for the over-winter survival of deer. The loss of critical wintering habitat would readily affect the deer population in this area. Due to the topographic nature of the area, deer depend strongly on protected bottomland hardwoods and valley slopes for survival during severe winters. In unprotected areas along the outer edge of the valley, snowdrifts prevent heavy use by deer. These factors resulted in high deer-density estimates in the valley and lower estimates in the take-line area or outer perimeter of the valley.

Estimates for firearm and archery hunting were based on the impact the project would have on critical deer wintering habitat and its subsequent effect on the deer population in the area without management.

Since the bulk of hunter-day losses were sustained in deer hunting and since big game requires the greatest acreage, compensation land needed for acquisition was based on the principal big game species for the area.

(1) Standard adopted by GREAT I - Recreation Work Group for use in current studies being conducted to determine future recreation facility and resource needs for the Upper Mississippi River corridor.

The amount of land needed for compensation was based on 582 deer-hunter-days lost in the project area times the 40 acres needed to support a deer-hunter-day times 20 percent (needed to provide area for peak demand which was estimated at 20 percent of the season's total of 582 hunter days(1)) = 4,656 acres. Active management would more than likely occur on the compensation land and would possibly increase the deer population, thereby increasing the hunters' success by at least 25 percent. This figure was chosen because of the nature of the most cost-effective management plans. Also, big game production would be adversely affected on some of the lands by flood storage inundation damage and recreational disturbance. Then, through improvement of hunting success through management, approximately 3,492 acres would be needed for compensation.

The 3,492-acre estimate does not provide for pursuit of small game, water fowl, or furbearers. Although these species could be pursued on many of the same lands, management prescriptions for these species would differ somewhat, and so the total lands needed for compensation would be somewhat greater than 3,492 acres.

These monetary calculations are based upon estimates of hunter-day losses derived from wildlife population estimates. As such, they reflect losses to the resource base, which is the primary concern of the compensation study. In actual practice, however, it is felt that the increased publicity, public ownership of land, and improved public access with the project would cause increases in hunting activity even without the compensation areas and even though the hunters would have less total land on which to hunt. Some remaining habitats would be degraded, and there would be less game in the hunter's bag.

E. Summary

Table 28 summarizes the aquatic and terrestrial monetary evaluations of the Twin Valley Lake project. Without mitigation, the $7,820 average annual equivalent loss can be considered an estimate of residual damages to fish ($398) and wildlife ($7,422), which can be treated as a project cost in economic analyses.

Tables 29 and 30 detail the dollar loss by project segment. Table 29 shows aquatic losses in man-days use of five main fish species in the Flood Pool (FP) and Conservation Pool (CP) under with project conditions. Supply and demand graphs were used in preparing average annual equivalent values.

Terrestrial losses for each project segment are further divided into white-tailed deer, small game, waterfowl, and furbearer-trapping groups (Table 30). Losses from the with project conditions are predominantly in the CP and Structures and Spillway (ST & SP) segments for white-tailed deer, small game, and furbearers, with lesser reductions in man-days use for the FP and Flood Pool Through Take Line (FP → TL) segments. Man-days use of waterfowl does not vary significantly between the with and without project conditions. Supply and demand graphs produced average annual equivalent values, from which a $7,422 loss was computed.

(1) Percent based on hunting seasons prior to 1973. During the 1973 season, 27 percent of the hunter-days occurred on 1 November. Since then, the trend shows a larger percentage of hunters on opening day. Hence, the estimate of 20 percent is considered conservative.

TABLE 23

SUMMARY OF MONETARY EVALUATION 1/

TERRESTRIAL	FUTURE WITHOUT PROJECT				FUTURE WITH PROJECT				DIFFERENCE WITH PROJECT	
Species/Group	Average Annual Use	Average Annual Worth	Average A.E.V.	Present Worth	Average Annual Use	Average Annual Worth	Average A.E.V.	Present Worth	Average Annual Use	Average A.E.V.
White-tailed Deer	1,088	8,320	8,641	121,157	506	3,987	4,003	56,131	-582	-4,672
Small Game	367	2,173	2,224	31,177	258	1,561	1,510	21,172	-109	- 712
Waterfowl	30	180	180	2,534	24	158	125	1,759	- 6	- 54
Furbearers-Trapping	499	2,996	2,986	41,867	363	1,916	1,862	26,111	-136	-1,085
-Pelts	---	2,210	2,304	32,311	---	1,403	1,413	19,810	---	- 892
SUB-TOTAL	1,984	15,879	16,335	229,036	1,151	9,025	8,913	124,983	-833	-7,422
AQUATIC										
Fishery	1,006	1,606	1,606	22,517	757	1,180	1,208	16,934	-249	-398
TOTAL	2,990	17,485	17,941	251,553	1,908	10,205	10,121	141,917	-1,082	-7,820

1/ Based on an interest and amoritization rate of 7 1/8% (Sept. 1979) for the life of the project.

TABLE 29

AQUATIC MONETARY EVALUATION

	Future Without Project (100 Years)							
	Man-Days Use By Planning Segments					Sport Harvest		
Species	AFP	FP	CP	TW-1	TW-2	Man-Days Use	Value Per Man-Day	Total Man-Day Value
Golden Redhorse	81	94	87	88	124	474	$1.50	$ 711
Shorthead Redhorse	13	17	9	7	12	58	1.50	87
Silver Redhorse	6	30	45	48	36	165	1.50	248
Northern Pike	29	26	29	23	22	129	2.25	290
Rock Bass	24	24	42	58	32	180	1.50	270
Total						1,006		$1,606

Present Worth = Dollar Value ($1,606) for 100 years at 7.125% interest (14.0207) for every $1 invested = $22,517.

Average Annual Equivalent Value = Area under supply-demand graph = $1,606.00.

	Future With Project (100 Years)							
	Man-Days Use By Planning Segments					Sport Harvest		
Species	AFP	FP	CP	TW-1	TW-2	Man-Days Use	Value Per Man-Day	Total Man-Day Value
Golden Redhorse	81	66	0	88	124	359	$1.50	$ 539
Shorthead Redhorse	13	12	0	7	12	44	1.50	66
Silver Redhorse	6	22	0	48	36	112	1.50	168
Northern Pike	29	18	0	23	22	92	2.25	207
Rock Bass	24	16	0	58	32	130	1.50	195
Total						737		$1,175

Average Annual Man-Days Use (From supply-demand graph) = Total Man-Days (75,720) ÷ Life of project (100) = 757

Average Annual Equivalent Value (A.E.V.) = (From supply-demand graph)

= $1,175	X 14.0702	(6-5/8% for 100 years/$1) =	$16,474.00
$ 2.30	X 10.4919	(6-5/8% for 20 years/$1) =	24.00
$ 2.25	X133.4475	(Pres. value annuity decrease) =	300.00
0.58	X926.6235	(Pres. value annuity decrease) X .2525 (Pres. worth)=	136.00
Total $1,180			$16,934.00

Average Annual Equivalent Value = $16,934 X .07132 (Partial Payment)
(A.E.V.) = 1,208

A.E.V. Without Project ($1,606) - A.E.V. With Project ($1,208) = $398 loss if project is accomplished.

TABLE 30 TERRESTRIAL WILDLIFE MONETARY EVALUATION

Future Without Project (100 Years)

Species	CP 540 Acres	FP 1150 Ac.	FP — TL 1338 Ac.	ST & SP 126 Ac.	Man-Days Use	Value Per Man-Day	Total Man-Day Value
	Man-Days Use By Planning Segments				Sport Harvest		
Firearms							
White-Tailed Deer	143	308	154	33	638	$9	$5,742
Archery							
White-Tailed Deer	143	143	143	0	429	6	2,574
Deer Subtotal					1,067		8,316
Ruffed Grouse	10	30	20	3	63	6	378
Hungarian Partridge	0	0	2	0	2	6	12
Squirrels	30	78	60	9	177	6	1,062
Jackrabbit	0	1	3	0	4	6	24
Cottontail	6	16	24	2	48	6	288
Woodcock	10	14	2	0	26	6	156
Small Game Subtotal					320		1,920
Waterfowl	15	14	0	1	30	6	180
Waterfowl Subtotal					30		180
Raccoon - Hunting	3	8	6	1	18	6	108
Raccoon - Trapping	16	28	20	0	64	6	384
Red Fox - Hunting	6	6	12	0	24	6	144
Red Fox - Trapping	8	16	16	0	40	6	240
Skunks	15	30	33	3	81	3	243
Weasels	8	18	14	2	42	3	126
Mink	75	135	0	5	215	6	1,290
Muskrats	21	20	0	1	42	6	252
Beaver	30	25	0	0	55	6	330
Furbearer Subtotal					581		3,117
TOTAL					1,998		$13,533
					Commercial value		2,209
							$15,742

Future With Project (100 Years)

Species	CP 540 Acres	FP 1150 Ac.	FP -- TL 1338 Ac.	ST & SP 126 Ac.	Man-Days Use	Value Per Man-Day	Total Man-Day Value
	Man-Days Use By Planning Segments				Sport Harvest		
Firearms							
White-Tailed Deer	0	110	99	11	220	$9	$1,980
Archery							
White-Tailed Deer	0	143	143	0	286	6	1,716
Deer Subtotal					506		3,696
Ruffed Grouse	0	18	13	1	32	6	192
Hungarian Partridge	0	0	0	0	0	6	0
Squirrels	0	76	83	3	162	6	972
Jackrabbit	0	0	0	0	0	6	0
Cottontail	0	13	8	1	22	6	132
Woodcock	0	14	2	0	16	6	96
Small Game Subtotal					232		1,392
Waterfowl	14	14	0	1	29	6	174
Waterfowl Subtotal					29		174
Raccoon - Hunting	0	5	5	1	11	6	66
Raccoon - Trapping	0	24	20	0	44	6	264
Red Fox - Hunting	0	6	6	0	12	6	72
Red Fox - Trapping	0	8	16	0	24	6	144
Skunks	0	24	15	3	42	3	126
Weasels	0	15	33	1	49	3	147
Mink	15	135	0	0	150	6	900
Muskrats	23	20	0	1	44	6	264
Beaver	5	25	0	0	30	6	180
Furbearer Subtotal					406		2,163
TOTAL					1,173		$7,425
					Commercial Value		$1,512
							$8,937

Average A.E.V. Computed as done in aquatic evaluation.

With Project A.E.V. = 8,913

Without Project A.E.V. = 16,335

Difference = 7,422 loss if project is accomplished.

VI. COORDINATION

The Fish and Wildlife Compensation requirements were determined by a team of fish and wildlife biologists representing the Corps of Engineers, Fish and Wildlife Service, and Minnesota Department of Natural Resources. The tri-agency team worked as a unit in collecting field data, evaluating the data in accordance with the HEP, and in the preparation of a supporting document. Thus, a Fish and Wildlife Compensation Plan was developed which considered the policies and positions of each of the participating agencies, and which met the goals and objectives of each of these agencies.

Throughout the development of the compensation plan, the tri-agency team and other members of their respective agencies, met with representatives of the Twin Valley Lake Citizens Advisory Committee, local sponsors (Wild Rice River Watershed District and Norman County), Congressional representatives, and other interests to discuss how the plan was being developed and to receive their suggestions. Their input was valuable in determining which compensation alternatives were most and least acceptable from various social, economic, and environmental perspectives.

During the 20-month study, six meetings of the Citizens Advisory Committee were held, with all committee meetings being open to the public. The Citizens Advisory Committee was very active and was especially concerned about the selection of an environmentally, socially, and economically acceptable fish and wildlife compensation plan. In conjunction with the Wild Rice River Watershed District, the committee played a key role in expediting resolution of fish and wildlife concerns and in obtaining local, State, Federal, and congressional support for the recommended plan.

The Fish and Wildlife Compensation Plan summary (Section IV) has been reviewed and is supported by the following:

Honorable Arlan Stangeland, U.S. House of Representatives
Minnesota Department of Natural Resources
Twin Valley Lake Citizens Advisory Committee
Wild Rice River Watershed District (project sponsor)
Norman County Board of Commissioners (project sponsor)
Red River Water Management District

The process and development of the Fish and Wildlife Compensation plan complies with provisions of the Fish and Wildlife Coordination Act and the intent of the National Environmental Policy Act of 1969.

VII. SELECTED BIBLIOGRAPHY

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

TWIN CITIES AREA OFFICE
530 Federal Building and U.S. Court House
316 North Robert Street
St. Paul, Minnesota 55101

IN REPLY REFER TO:

MAY 09

Colonel William W. Badger
District Engineer, St. Paul Dist.
U.S. Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Badger:

The preliminary draft of the Fish and Wildlife Compensation Plan for the proposed Twin Valley Lake flood control project in Norman County, Minnesota has been reviewed, and our comments follow.

The Compensation Plan is based upon the U.S. Fish and Wildlife Service's Coordination Act Report for Twin Valley dated January 1978. In accordance with Habitat Evaluation Procedures, this report requested two areas for easement and fee title acquisition with habitat management as compensation for project-related fish and wildlife losses. The 1,750-acre Faith Area, approximately one mile south of the project area, would be acquired in fee title and the 740-acre Downstream Area would be acquired in easement. Specific habitat improvement measures would be implemented in both areas to varying degrees.

The preliminary draft of the Fish and Wildlife Compensation Plan accompanying your April 22, 1980 letter contained a major modification to our recommended plan. This modification, being a recalculation of the gains in Management Potential Unit Value (MPUV), reflects fee title acquisition in the Downstream Area instead of easement. Thus, the net gains of the Compensation Plan project increase by 4,777 Habitat Units (HU's) and reduce compensation needs in the Downstream Area by approximately 320 acres. This change in the Compensation Plan is in basic agreement with the Habitat Evaluation Procedure which indicates that the more management provided, the fewer acres of land acquisition needed. Assuming that management will occur to 100% of the Downstream Area's potential, the Fish and Wildlife Service supports this change. The change in the boundary of the Downstream Area is not presented in this draft preliminary plan. Since this area is to play a significant part in fishery habitat compensation, we would like to have input in the delineation of the new Downstream Area for compensation.

EXHIBIT 1

Supporting data documenting fee instead of easement acquisition in the Downstream Area must be updated for your draft Compensation Plan. The narrative on pages 99 and 104 continues to refer to 'easement'. Tables 17-29 refer to the higher acreage and the lower MPUV that would result from an easement in the downstream area. This data must be updated to reference a 520-acre acquisition and the resultant increased MPUV due to more intensive management.

We also recommend that as part of the project, a follow-up study monitoring the habitat management components of the Compensation Plan be implemented. This will be of value in assessing the projects, since the Compensation Plan assumes 100% of the management potential in the Downstream Area will be achieved.

When implemented with requested refinements, the Compensation Plan, in the view of the U.S. Fish and Wildlife Service, will provide adequate consideration for fish and wildlife resources in the Twin Valley Lake project area.

These comments have been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and are consistent with the intent of the National Environmental Policy Act of 1969. This project was also examined for conformance with Executive Orders 11988 and 11990.

Sincerely yours,

Richard E. Toltzmann

Richard E. Toltzmann
Acting Area Manager

cc: Minn. DNR, St. Paul

EXHIBIT 1

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
CENTENNIAL OFFICE BUILDING · ST. PAUL, MINNESOTA · 55155

May 12, 1980

DNP [illegible]
(612) [illegible]

William W. Badger, Colonel
Department of the Army
St. Paul District Corp of Engineers
1135 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

We have reviewed the preliminary draft of the Twin 'ey Fish and Wildlife Compensation Plan. We will support a reduction of 'roximately 320 acres in the compensation acreage based on increased fist ' wildlife gains resulting from fee acquisition and management in th. ſ .nstream Area.

If the acreage reduction is to occur, we recommend that the hillside portion be removed from the proposed downstream easement lands. The floodplain area or bottomland along the river should be acquired in fee title to State T.H. 32. This would still allow angler and other recreational access along the river, maintain wildlife travel corridors and allow partial fishery mitigation through the development of instream fishery structures and management of the bottomland wildlife habitat.

The gains resulting from the Twin Valley HEP analysis rely on the appropriation of funds for the acquisition and management of lands to adequately provide fish and wildlife compensation. If necessary we are willing to provide assistance in identifying recommended areas for reduction of acreage in the Faith WMA supplement and/or Project area to fulfill the HEP principle.

We would also like to provide the following comments concerning the preliminary draft of the Compensation Plan.

Page 70, item 2a should read "The terrestrial habitat types in the Downstream area were assumed to be in the same proportion as those in the Project area."

Page 78, 4th paragraph: The base value was obtained by using the sum of the upland hardwoods evaluation as a standard for habitat type comparison. The sum of the ratings for each habitat type was then compared to upland hardwoods to obtain a subtotal comparison ratio for each habitat type and establish a base value of one for upland hardwoods.

Page 84, column 3 - upland brush HU's gained should read 17,606 (see Table 2, page 11) [illegible] will change columns 6 and 9.

EXHIBIT 2

Colonel Badger
May 12, 1980
Page Two

Page 93, item C: There is no Statewide Wildlife Management Plan scheduled for completion in 1979. However the present State Wildlife Management Policy is in the process of being revised.

Page 97, 2nd paragraph: In addition to the discussion presented, the compensation of aquatic stream losses further downstream from the Project Area was also judged impractical because it was preferable to keep fish and wildlife mitigation measures in the vicinity of the project impacts.

Page 101, Table 24a: How do we lose 5.4 acres to the downstream fishery?

Page 111, Table 26: Land acquisition costs appear to be overestimated because fee title lands are listed at $900 per acre based on October, 1979 price levels and were only listed at $300 per acre in the Fish and Wildlife Services Special Report, January, 1978. The $900 per acre figure would appear to reflect prime cropland and is considerably higher than the $565 per acre figure quoted for unimproved farmland in Norman County by the Minnesota Rural Real Estate Market in 1979. The majority (approximately 75%) of the compensation lands are not croplands and some of the croplands are marginal so acquisition costs should be lower than indicated.

We appreciate the opportunity to comment on this revision of the Twin Valley Fish and Wildlife Compensation Plan and look forward to continued coordination on this project.

Sincerely,

Joseph N. Alexander
Commissioner
Department of Natural Resources

JNA:LD:jlf

cc: Mr. Harvey Nelson, USFWS
Robbin Blackman, COE

EXHIBIT 2

PART TWO:

WATER QUALITY EVALUATION

WATER QUALITY
TWIN VALLEY LAKE - WILD RICE RIVER
MINNESOTA

1.000 INTRODUCTION

1.001 The objectives of this study are to evaluate the potential quality of the aquatic environment in the proposed Twin Valley Lake and to determine what effect, if any, discharges from the reservoir would have on downstream reaches. The data and determinations presented in this text are based principally upon the findings of the Water Quality Report developed by the U.S. Army Engineers Waterways Experiment Station (WES), Vicksburg, Mississippi (Technical Report Number EL-79- 5, Water Quality Evaluation of the Proposed Twin Valley Lake, Wild Rice River, Minnesota) and in part upon the St. Paul District Design Memorandum No. 4 - Water Quality, January 1980. A limited number of copies of both reports are available for review at the St. Paul District Office.

2.000 WATER QUALITY CLASSIFICATION AND STANDARDS

2.001 The Wild Rice River has been classified as a 2B stream by the Minnesota Pollution Control Agency (MPCA, 1973). Under this classification, the quality of the aquatic resource must be maintained to provide for the propagation and maintenance of cool or warm water sport or commercial fishes and be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. Also, under this classification, the river must meet those standards in classes 3C (industrial consumption), 4A (irrigation) and 4B (livestock and wildlife uses), 5 (navigation and waste disposal), and 6 (any other possible use) which are not listed under the most restrictive class 2B. Table 1 summarizes the standards which must be met under the above classification.

2.002 The MPCA presently is revising the regulations for the classification system specified in WPC 14 (1973). For comparison purposes, Table 1 also presents the new parameters for the classification system.

3.000 A REVIEW OF EXISTING WATER QUALITY DATA

3.100 Wild Rice River Data

3.101 Water quality data were taken by the U.S. Geological Survey (USGS) on the Wild Rice River from September 1974 through December 1977 at a site approximately 1.2 miles downstream from the proposed dam site. The data collected are considered representative of the water which would enter the proposed impoundment. Water samples were collected monthly except during April through October 1976, when the sampling frequency was changed to a weekly schedule.

3.102 The average annual runoff during the sampling period was approximately 2.6 inches per year. Generally, the streamflow at Twin Valley rises in late March or April from snowmelt with the largest flow usually in April. The flow remains high through June and then slowly recedes. Approximately 62 percent of the total annual flow at Twin Valley occurs in 3 months: April through June. During periods of drought, the lakes in the upper end of the watershed sustain flows in the Wild Rice River.

3.103 Data obtained during the 3 study years indicate that the river does not have any major water quality problems (see Table 2).

3.200 National Eutrophication Survey Data

3.201 In 1972, the Environmental Protection Agency (EPA) initiated the National Eutrophication Survey (NES) to investigate the threat of accelerated eutrophication to freshwater lakes and impoundments. Of the 815 lakes and reservoirs surveyed between 1972 and 1976, 78 were located in Minnesota and 14 in North Dakota. Selected physical, biological, and chemical parameters for 27 of the NES lakes and reservoirs located within 125 miles of the proposed reservoir are summarized in Table 3. Although these lakes and reservoirs were studied for 1 year with only 3 samples taken, the number of lakes surveyed are believed to provide a reasonable data base to compare and evaluate the water quality and eutrophication potential of the proposed Twin Valley Lake.

4.000 WES INVESTIGATIONS INTO THE QUALITY OF THE AQUATIC ENVIRONMENT FOR THE PROPOSED TWIN VALLEY RESERVOIR

4.100 Introduction

4.101 The U.S. Army Corps of Engineers Waterways Experiment Station (WES) employed a variety of techniques to predict the potential water quality and eutrophication potential of the proposed Twin Valley Reservoir. The techniques used included both mathematical simulations and laboratory studies. Background data and coefficients used in these model studies were obtained from existing data (i.e., data from the USGS, NES, and other sources previously identified in this text) and from other studies performed by WES on Wild Rice River water and soil samples obtained from the project site.

4.102 The following studies were performed by WES in order to achieve the objectives stated above: (1) algal bioassays, (2) mathematical simulation - water quality and thermostratification, (3) water quality changes in the bottom water during the initial impoundment of the reservoir, (4) the potential for the establishment and growth of aquatic plants, (5) reservoir clearing and filling, and (6) management alternatives. A discussion of the objectives and results for each analysis is presented below along with a comparison to appropriate water quality criteria where applicable.

4.103 Before discussing the WES studies, the mathematical model assumptions and limitations should be considered. The most important assumptions would be that the model is uni-dimensional and that the predictions are valid only in the deeper part of the pool near the dam, not in the headwaters, coves, or embayments. The predictions are also valid only under aerobic (with oxygen) conditions. It may be possible to predict when the dissolved oxygen (DO) goes out, but there is no mechanism in the model to account for the oxygen debt that would build up under anaerobic (without oxygen) conditions. Model predictions represent those conditions which may exist when the transients in the water quality from the initial filling have diminished. This may occur in 5 or more years.

4.200 Algal Bioassay

4.201 Prior to beginning model studies, algal bioassays were conducted on water samples collected at the proposed Twin Valley project site to determine those nutrients that would potentially limit phytoplankton growth and the availability of the existing nutrients for plankton uptake. This data was required to determine if the existing data would need to be updated and to help select appropriate coefficients for the mathematical ecological simulations. For comparison, algal bioassays were also performed on water samples taken from Dayton Hollow Reservoir. Dayton Hollow Reservoir was selected because it is morphologically similar and is situated in approximately the same geographical location as the proposed Twin Valley Reservoir. Hence, a comparison of in-lake nutrient concentrations and availability within a riverine environment could then be made between an existing reservoir and the proposed impoundment.

4.202 The chemical analyses and bioassays from Dayton Hollow Reservoir indicated that conditions in the reservoir and river were similar. Therefore, conditions in proposed Twin Valley Lake may be similar to those found in the Wild Rice River. The bioassays from the Wild Rice River indicated that either phosphorus or nitrogen could be limiting and that, at times, another constituent such as carbon may limit growth. The probability is higher, however, that phosphorus may be limiting in proposed Twin Valley Lake because some phosphorus may co-precipitate out of the water column with calcium carbonate and because many blue-green algae have the ability to fix nitrogen. The bioassays also indicated that the nutrients were in a completely available form and that the waters of the Wild Rice River were relatively infertile.

4.300 Mathematical Simulations

4.301 In order to predict the potential water quality and thermostratification potentials of the proposed reservoir, WES employed a modified research version of the Water Quality for River-Reservoir Systems (WQRRS) reservoir model. This model has the capability to simulate reservoir ecosystems through the use of existing water quality data (i.e., from the river in question and other lakes and reservoirs with similar physiological conditions).

4.302 The water quality model was used to predict the water quality and trophic status of the proposed lake and to determine the sensitivity of the model to various chemical and nutrient coefficients and parameters. A thermostratification model was used to calibrate the mixing and heat transfer coefficients required for the ecological model simulation, to evaluate the selective withdrawal capabilities of the project with respect to a downstream natural temperature objective, and to determine if the proposed reservoir would stratify thermally.

4.303 From the existing water quality data (i.e., USGS data), 3 years were selected to simulate the hydrometerological effects on project water quality. The selected years (i.e., 1971, 1975, and 1976) represented the average, wet, and dry conditions within the watershed, respectively.

4.310 Thermal Stratification - Based on data collected from surrounding lakes with similar morphology which stratify weakly, and in which thermoclines form at a depth greater than 29.5 feet (31.2 feet is the maximum depth of the proposed lake), thermal stratification within Twin Valley Lake is not expected to occur. However, based on the mathematical simulations performed by WES, intermittent stratification is expected to occur from May through July. These periods of stratification may last from 5 to 45 days or longer. Bottom isolation would not exist in the classical sense and materials within the bottom area would mix with overlying water columns.

4.311 The sheltering effect of the surrounding terrain is not expected to be significant. For the months of June through October, the prevailing wind direction (south-southeast) would be perpendicular to the major axis of the lake; and, under these conditions, the sheltering effect should be the greatest. Based on laboratory and field data, the sheltering effect is approximately eight times the vertical relief. Assuming the surrounding relief to be on the order of 66 to 82 feet and a typical fetch to be 1,968 feet, the sheltered area would extend 525 to 656 feet into the lake. Less than one-third of the lake surface would be sheltered from the wind, and in-lake mixing should not be affected.

4.320 Dissolved Oxygen - The Minnesota standard for dissolved oxygen (DO) in the category covering the discharges from the proposed Twin Valley Lake requires not less than 6 milligrams per liter (mg/l) from 1 April through 31 May and not less than 5 mg/l at other times (MPCA, 1973). Discharges from Twin Valley Lake are not expected to violate this standard.

4.321 Based on the mathematical simulations, zero oxygen (anoxic) conditions could begin to develop in the deeper areas of the reservoir within 5 to 15 days following the onset of thermal stratification. The duration of anoxia would depend on hydrometerological conditions and the resulting thermal stratification. Periods of up to 100 days are possible but are unlikely. Anoxia would be limited to the bottom 7 to 10 feet of the lake which would comprise less than 15 percent of the lake volume.

4.330 Phytoplankton Development - WES studies indicated that the types of algae (i.e., blue-green (cyanophyta), green (chlorophyta), diatoms (chrysophyta), and dinoflagellates (pyrrophyta)) found within the surrounding lakes would likely occur within Twin Valley Lake. Diatoms and green algae are expected to dominate in the spring and fall, while blue-green algae should be dominant in the summer. Many species of the blue-green algae would accumulate on the water surface during large blooms. Since the prevailing winds during the summer months would be from the south-southeast, blue-green algae would tend to accumulate on the north side of the lake.

4.331 Based upon the mathematical simulations, algal blooms are expected to range from 0.5 to 40.9 grams per cubic meter (g/m^3). For comparative purposes, a visible bloom would be 0.7 g/m^3 and a nuisance bloom 1.5 g/m^3. Using the conversion factor, 0.23 g/m^3 dry weight = 1 microgram per liter (ug/l) chlorophyll a, the magnitude of the predicted algal blooms in terms of chlorophyll a concentrations would be 2 to 89 ug/l. These values are comparable to the algal blooms, with a chlorophyll a concentration of 1 to 130 ug/l, found in the surrounding lakes studied by NES. Twin Valley Lake is expected to have a chlorophyll a concentration of 20 to 50 ug/l, with larger concentrations expected to develop in the headwater regions and coves.

4.332 One factor that was not incorporated into the simulations is decreased light penetration due to turbidity and suspended solids. The USGS data indicated suspended solid concentrations of several hundred milligrams per liter in the stream. During and following storm events, these concentrations would be expected to increase and be transported into the pool. The extent of decreased light penetration and settling rate of these particles is unknown, but it could significantly reduce the phytoplankton response to increased nutrients.

4.340 Trophic State - The trophic state of an impoundment refers to its degree of nutrient enrichment. Lakes are generally classified as oligotrophic, mesotrophic, or eutrophic in the order of increasing enrichment. Recent studies have indicated that the demarcation between mesotrophic and eutrophic lakes is a chlorophyll a concentration of 7 to 10 ug/l (Great Lakes Group - 7 to 8 ug/l and NES - 10 ug/l). Using this criteria, the WES modeling, predictions (i.e., estimated chlorophyll a concentration of 20 to 50 ug/l), and data from surrounding impoundments (i.e., values of 1 to 130 ug/l were found) indicate that the proposed Twin Valley Lake would be eutrophic.

4.341 The Environmental Protection Agency (1976)[1] has recommended that phosophorus concentrations should not exceed 0.05 milligrams per liter (mg/l) in any stream entering a reservoir and that in-lake concentrations should not exceed 0.025 mg/l in order to control cultural eutrophication. In other studies (i.e., Miller et al, 1978)[2], impoundments were considered eutrophic if they contained 0.015 mg/l bioavailable phosphorus and 0.165 mg/l bioavailable nitrogen. The fact that mean phosphorus and total soluble inorganic nitrogen (TSIN) concentrations in the Wild Rice River were 0.057 mg/l and 0.11 mg/l, respectively, also indicates that the proposed Twin Valley Lake would be eutrophic.

4.350 Fecal Coliforms - The Minnesota standard for fecal coliforms is 200 Most Probable Number per 100 ml as a monthly geometric mean (MPCA, 1973)[3]. The EPA-recommended criterion for body contact recreation is 200 colonies/100 ml based on a logarithmic mean of a minimum of five samples in 30 days (EPA, 1976). The value of 200 colonies/100 ml was used in this analysis.

4.351 The WES modeling simulations predicted no problems in meeting the above criteria. However, since the model is one-dimensional and unable to simulate longitudinal variations and since some of the inflow counts exceeded 200 colonies/100 ml, it is expected that periodic violations may occur in the headwater regions of the reservoir.

4.400 Potential Water Quality Changes in the Bottom Waters During the Initial Impoundments of the Proposed Reservoir

4.401 The objective of this study was to evaluate the potential effects of the soil-water interactions occurring under anoxic (no oxygen) conditions on the water quality of the proposed reservoir. Water quality parameters of major concern in this simulation were dissolved oxygen (DO) and biochemical oxygen demand (BOD), pH, nutrients of major importance in supporting algal growth, sulfide, organic carbon, color, and the metals iron and manganese.

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[1] U.S. Environmental Protection Agency. 1976. Quality Criteria for Water. Washington, D.C.

[2] Miller, W.E., J.C. Greene, and T. Shiroyama. 1978. The Selenastrum Capricornutum Pritz Algal Assay Bottle Test. U.S. Environmental Protection Agency, EPA-600/9-78-018.

[3] Minnesota Pollution Control Agency. 1973. Minnesota State Regulations: Rules, Regulations, Classifications, and Water Standards.

4.402 Two generally representative areas from within the boundaries of the proposed reservoir were selected as soil sampling sites. Site I represented the most extensive plant community and soil type (i.e., mature floodplain forest and alluvial land, frequently flooded), while Site II represented the second most abundant soil type found within the proposed lake (alluvial land, occasionally flooded). Each soil sample consisted of both the A- and B-horizons. The A-horizon includes the humus layer (i.e., partially decomposed material) and the first few inches of the soil, while the B-horizon is all soils below the A-horizon. Vegetation samples from both sites were also collected and analyzed.

4.410 Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) - The biochemical oxygen demands of the soils and the vegetation taken from the two study sites are high and are likely to cause a significant depletion in the levels of DO of the overlying waters, even though the proposed impoundments should not exhibit strong thermal stratification. The oxygen depletion rates observed for the first year of inundation of the A-horizon and litter layer in the WES study fall close to the range observed in other reservoirs. With oxygen consumption rates of 520 mg $O_2/(m^2 \times day)$ for the first year of impoundment, the bottom waters would tend to become anoxic within a short period if the lake stratifies with bottom temperatures in the 64° to 73°F range. Actual in-lake oxygen depletion times would depend on depth of the water column between the bottom of the reservoir and the hypolimnetic-metalimnetic interface, and on the nature and fate of organic loadings entering the hypolimnion from the watershed above the reservoir and/or from the epilimnion.

4.411 Once the area has been flooded for a year, the oxygen demand would diminish somewhat due to the losses of some of the readily available organic matter through decomposition, leaching, and/or suspension and washout of particulates. If the existing A-horizon of the soil remains unaltered by deposition from the first to second season, the oxygen demand would fall from an estimated 520 to approximately 438 mg $O_2/(m^2 \times day)$, a decline of more than 80 mg $O_2/(m^2 \times day)$. Whether the demand will be reduced by a similar extent from the second to the third years of inundation cannot be assessed at this time. Should the bottom waters remain aerobic during the first year of impoundment, a larger decrease in the oxygen demand would tend to occur as a consequence of a more efficient and complete utilization of organic matter under aerobic conditions relative to anaerobic circumstances. Based on the rate of decrease in oxygen demand observed between the first and second simulations, it appears that a minimum of 5 years of anaerobic/aerobic conditions will be required to decrease the oxygen demand to the 110 to 120 mg $O_2/(m^2 \times day)$ level observed for the first year of inundation of the B-horizon.

4.420 Carbon, Nitrogen, and Phosphorus - The WES studies indicated that the release of organic forms of carbon, nitrogen, and phosphorus from the soil into the water column would be quite extensive, even under fully aerated conditions. A release of organic materials from these soils would not be surprising in view of the high levels of organic matter originally present. The total organic carbon content of the A-horizons of Sites 1 and 2 averaged 6.3 percent, which translates into a total organic matter content of 11.7 percent. This concentration is an average of the entire A-horizon, exclusive of the top-most litter layer but including all underground macro-organic matter; and, although the concentration is higher than the average value for Minnesota soils, it is well within the range for these materials.

4.421 The values for the total dissolved organic and inorganic forms of carbon, nitrogen, and phosphorus presented in the WES report are not necessarily the actual concentrations that will be achieved in the real system. Since water columns of reservoirs are, under normal stratified conditions, not well mixed, the final concentrations of the component nutrients could be much less than that found in the WES studies. In this case, however, the concentration of nutrients would increase toward the bottom of the water column.

4.422 The maximum levels of organic carbon reported in the study (approximately 90 mg/l) were sufficient to tie up nearly 250 mg/l of DO, assuming all carbon to be metabolizable to carbon dioxide. Thus, even at more dilute concentrations, a capacity to exert a biological oxygen demand (BOD) will be present. The nitrogen and phosphorus values present in organic materials after the release of the latter from the soil do not represent as much of a direct contribution to the pool of plant-growth-stimulating nutrients as do their inorganic counterparts. If the proposed impoundment does become anoxic during the first year of filling, the subsequent buildup of inorganic nutrients would, up to a period of 50 to 60 days, show gradual increases in inorganic carbon, phosphate-phosphorus, and ammonium nitrogen. These substances, if released downstream or if released to the surface waters during the next period of mixing, would represent a potential source of plant-growth nutrients. Moreover, the concentrations of ammonium observed herein are high enough to cause difficulties with biological oxygen demands exerted in downstream areas as a consequence of the biological oxidation of ammonium to nitrate and nitrite.

4.430 Free Ammonia - Simulations of outflows from the proposed Twin Valley Reservoir, performed by WES for the 3 study years (see 4.303), showed that pH, temperature, and ammonia-nitrogen levels could fluctuate from 7.7 to 9.3, 32° to 77° F, and 0.0 to 0.34 mg/l, respectively. The highest values for all three parameters occurred in mid to late summer following a large algae bloom. The study also showed that the percentage of un-ionized ammonia present in the outflows would increase significantly when ammonia-nitrogen, pH, and temperature levels were high. Based on the preceding information and on an analysis of the pH, temperature, and ammonia levels that can occur in the Wild Rice River, coupled with the fact that the model used by WES could not simulate increased levels of ammonia likely to occur under anaerobic conditions, it is probable that the proposed un-ionized ammonia-nitrogen standard of 0.04 mg/l could be violated occasionally during the summer months.

4.440 Sulfide - The sulfate contents of both the inflowing Wild Rice River and the soils to be inundated are high. If the proposed impoundment follows the trends observed in the WES studies, it may become anoxic; and if it remains anoxic for a number of weeks, there is a strong possibility that hydrogen sulfide would be released. While the resultant levels of sulfide in the water can be limited to a certain extent by the formation and precipitation of insoluble ferrous sulfide, the possibility cannot be excluded that some of the sulfide would escape and that its rotten egg odor would be released from the lake. More likely, however, is the potential release of sulfide with any bottom withdrawals made from the reservoir and subsequent odor and oxygen demand increases downstream from the impoundment.

4.450 Iron and Manganese - The levels of iron and manganese released into the water column by virtue of the solubility of their reduced forms are not as high as those achieved under anaerobic conditions in other situations. Moreover, the WES study indicated that the reddish coloration which can result from the oxidation of iron when anaerobic waters containing the ferrous ion are released

via bottom withdrawals would likely be more noticeable from the turbidities created by flowing iron oxyhydroxides than by the actual color properties of the material. The color imparted by the movement of humic materials from soil into the water would likely be more intense than that of iron oxides. Insoluble ferrous sulfides do give a black color, but these tend to precipitate rapidly and the resultant problems are odors (sulfide) and oxygen demand (BOD and IOD)[4].

4.460 Color - The yellow color acquired by waters that contact soils with high levels of organic matter would be apparent for the first few years, both in the waters of the impoundment and in releases from it. However, the color should change little from existing conditions or be no worse than any of the natural lakes in the same region and should have only a minor impact on water quality, unless the water serves as a source of potable water supply; in this case, increased treatment costs would be incurred.

4.470 pH and Conductivity - The pH will decrease under anaerobic conditions, but the huge buffering capacity of the carbonate-bicarbonate buffering system should prevent the pH from dropping to unacceptable levels. The increase in conductivity observed in the WES study indicates a gradual increase in dissolved substances under anaerobic conditions, and this is confirmed by the observed increase in inorganic forms of carbon, nitrogen, and phosphorus.

4.500 Establishment and Growth of Aquatic Plants in the Proposed Reservoir

4.501 The principal objective of this study was to determine the potential for the development of aquatic plants within the proposed reservoir. Other aspects of the study were to determine the area of potential growth, the factors which may limit growth (i.e., light, sedimentation, and sediment types), and the type of plants which could become established.

4.502 On the basis of probability of propagation, those species presently found within the Wild Rice River Watershed are expected to develop within the project area. A listing of these species can be found in the Final Environmental Impact Statement for this project. Predicted sediment loading (based on USGS data) in the proposed reservoir would provide an ideal nutritional environment for rooted aquatic plants. However, sediment-associated turbidity, with consequent reduced light penetration, may locally impede the distribution of submergent plants. The WES study predicted that light would become limiting at a depth of approximately 10.8 feet. Based on this information, approximately 46 percent of the lake's surface area could be colonized by aquatic plant species (see Figure 1). Emergent vegetation would be restricted to immediate shoreline regions. In conclusion, the WES studies indicate a favorable potential for aquatic plant establishment and growth in Twin Valley Lake.

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[4] Immediate oxygen demand: IOD measures the amount of oxygen consumed within 15 minutes once aerobic waters are exposed to anaerobic water.

4.600 Reservoir Clearing and Filling

4.601 During the first 6 to 8 years after project filling, the reservoir would undergo dynamic biological and chemical changes. Many of the changes are directly or indirectly associated with decaying organic matter which would be inundated upon filling. To minimize the impact of reservoir filling on water quality, WES performed laboratory studies using soil samples from the project area. A summary of the results of these studies follows.

4.610 Influence of Clearing on Water Quality - Analysis of the vegetation from the two samples sites (see 4.410) from within the reservoir area indicated that the biochemical oxygen demand (BOD) from these materials should be quite high. This is based on an average 5-day BOD of 35.6 mg O_2/1 of water per gram of vegetation. This value is approximately 3 to 4 times higher than the BOD for the A-horizon soil samples previously identified. WES concluded that the common practice of removing vegetation only in the flood pool region where residues of dead trees and shrubs can have negative aesthetic impacts on recreation would probably also be desirable for the present impoundment. More specifically, the vegetation on the sites examined has a large shrubby and herbaceous component; thus, the BOD of this material is exerted by substances that are relatively easily decomposed when compared with a mature, climax forest. WES studies indicate that the removal of bottomland vegetation would considerably reduce the BOD of the sites studied (per square meter basis) and would reduce the project's impacts on water quality, particularly in the first 1 to 3 years after filling.

4.620 Influence of Soil Removal on Water Quality - The A-horizons of the study sites together with the litter layers have a large BOD, which is reflected in the rapid oxygen depletion rates observed in the soil-water reaction units used by WES. Removal of the A-horizon would decrease the oxygen demand approximately fourfold for the first year of flooding; and, although the oxygen demand of the B-horizon is still quite high, the lower demand of the B-horizon in conjunction with the predicted tendency of the reservoir to undergo intermittent mixing would probably preclude the development of prolonged anoxic conditions. Moreover, preliminary results obtained in the WES studies of the B-horizon suggest that this layer would release a much lower level of plant-growth-supporting nutrients to the overlying water column. Note that no attempt is made here to anticipate the amount or nature of A-horizon materials that will enter the reservoir from upstream areas and settle in the reservoir. Obviously, materials of a highly organic nature would tend to aggravate the depletion of dissolved oxygen (DO). Materials of a more mineral nature would tend to seal off the bottom of the reservoir after deposition, thus lowering any oxygen demand. It should be noted that the A-horizon is relatively deep (9.8 to 17.9 inches), rendering removal an extremely expensive proposition.

4.630 Influence of Filling Practices on Water Quality - The WES studies show that both color and oxygen demand problems improve with reflooding and re-exposure of the soil to fresh waters. This practice of filling and flushing the impoundment two to three times prior to final filling could have a positive effect on reservoir water quality. However, since a great deal of the aging process depends as much on the breakdown of moderately degradable components (cellulose, hemicellulose) as on the movement of readily soluble components out of the reservoir, filling practices which tend to accelerate degradation of organic matter while avoiding severe BOD problems are recommended. Hence, WES suggested use of a sequence involving two or three flushings to remove easily soluble or

leachable components, followed by slow incremental filling to keep the reservoir shallow for as long as possible to promote oxygen exchange with the atmosphere and consequent efficient decomposition of organic matter.

4.700 MANAGEMENT ALTERNATIVES

4.701 WES evaluated several alternative operational approaches to assess their impact on water quality and project purposes. These approaches included bottom and surface withdrawal, lower and higher pool elevations, increased minimum and decreased maximum releases, and destratification.

4.710 Withdrawal - The mathematical simulations indicated that the proposed Twin Valley Lake could be operated to meet the downstream natural stream temperature objective with bottom, surface, or selective withdrawal. In addition, no differences were observed for in-lake water quality with the three withdrawal schemes. Since the lake would not strongly stratify, WES felt that selective withdrawal offered no distinct advantages over bottom or surface withdrawal. Bottom withdrawal was therefore recommended.

4.711 WES suggested that if a selective withdrawal structure is considered necessary to provide flexibility in structure operation and maintenance, the original design should be modified and consideration should be given to:

a. Adding a "piggyback" gate to the flood control gate to release small flows (i.e., less than 1.4 cubic meter per second (m^3/sec)).

b. Using a single wet well. Since the proposed lake is not expected to stratify strongly and since the withdrawal zone would usually extend through the entire water column, blending between ports was not a major consideration. However, blending would still be possible in a single well system because blockage due to density stratification in the wet well was not expected to be a problem.

c. Reducing the size of the water quality ports for a maximum release of approximately 4.3 m^3/sec.

4.720 Raising and Lowering Conservation Pool Elevation - During the model studies, pool elevations were raised and lowered by 5 feet to determine the effect of pool elevation and residence time on water quality. The simulations for the higher pool elevation corresponded to two different project operations. In the first operation, the pool was held constant at the higher elevation all year. This operational scheme would adversely affect flood control operations and benefits. In the second operation, dual storage operation was assumed. The pool was raised from its winter conservation level to the summer conservation pool level during the spring flood.

4.721 Generally, the simulations indicated that the lower the pool, the better the DO and the worse the phytoplankton. Lowering the pool elevation was not recommended because recreation would be severely affected by increased phytoplankton and reduced surface area. Aquatic plants would also be a problem. For these reasons, dual storage was considered to be the only effective way to operate the pool. The flood control benefits would be retained along with a larger pool for recreational purposes. Although the phytoplankton decreased slightly at the upper pool level, the duration and extent of anaerobic conditions increased. The slight decrease in phytoplankton is probably not worth the increased period of anaerobic conditions. Therefore, the original pool elevation (1063 feet msl) was recommended.

4.730 Increasing Minimum and Decreasing Maximum Releases - Increasing the minimum release from 4.9 to 14.8 cubic feet per second (ft^3/sec) in 1976 (an extremely dry year) had no effect on in-lake water quality; however, conditions would probably have improved downstream. Since the routings and simulations were for only 1 year, the effects of a prolonged drought on water quality could not be determined.

4.731 Decreasing the maximum release to 16.94 ft^3/sec in 1975 significantly altered the water quality of proposed Twin Valley Lake for the worse. Since 1975 was the second wettest year on record and since the flood occurring near the end of June was rare, the realization of these conditions would also be rare. The simulations did, however, indicate that whenever floodwaters are stored, water quality would be adversely affected.

4.740 Destratification - With destratification, the lake remained aerobic all year. Although phytoplankton blooms were predicted to increase, the simulation could not determine the precise effects of mechanically mixing the lake.

5.000 SUMMARY OF WES CONCLUSIONS AND RECOMMENDATIONS

5.001 Model studies indicated that water quality impacts of reservoir construction and operation would be minimal and limited to the addition of color (yellow) and soluble organic forms of carbon, nitrogen, and phosphorus to the water, provided that the proposed reservoir does not stratify for more than 8 to 10 days. Intermittent periods of thermal stratification and associated lowered oxygen levels in the deeper areas are, however, expected to occur from May through July. Even though low oxygen levels may develop in the reservoir, MPCA guidelines for DO levels will not be violated by reservoir discharges. Under aerobic conditions, the impact of the organic material on water quality is larger in terms of BOD exerted by the material itself than the concentration of plant nutrients that may be accumulated. The potential for DO depletion as a result of the oxygen demand could be minimized by reducing the residence time of the water in the reservoir. A period of successive fillings and flushings during the initial impoundment period could minimize this demand because short residence times could promote good dilution and because soluble and leachable components would be readily removed.

5.002 Anoxic conditions could potentially develop within the hypolimnion if stratification persists for longer than 14 to 19 days (i.e., the hypolimnion would go anoxic 5 to 10 days after stratification forms). Once anerobic conditions have developed, the inorganic forms of carbon, nitrogen, and phosphorus would become the predominant nutrient forms available within the hypolimnion. Bottom withdrawals from the reservoir under these conditions would release increased concentrations of inorganic forms of carbon, nitrogen, and phosphorus. These nutrients could also be released to the surface waters during periods of wind-induced mixing.

5.003 Within 10 to 15 days following the development of thermal stratification (i.e., an average of 11 days of incubation), hydrogen sulfide production is probable. The development of hydrogen sulfide can be detected by the presence of a black precipitate of ferrous sulfide and a rotten egg odor which is characteristic of this chemical compound. Although a rotten egg odor and a black precipitate of ferrous sulfide may be detectable under certain conditions, it is considered a negligible problem.

5.004 Studies of the BOD of composite vegetation from both sites studied indicate that the vegetation would have a BOD approximately four times that of the A-horizon of the soil. The shrubby and herbaceous nature of much of the vegetation at the study sites indicates that much of the growth is easily decomposable. Removal of this bottomland vegetation could reduce the oxygen demand, although quantitative data are not available at this time. The initial oxygen demand of samples of A-horizon and litter from the study site was approximately 520 mg $O_2/(m^2 \times day)$. This demand decreased approximately 80 mg $O_2/(m^2 \times day)$ after more than 100 days of flooding followed by reaeration for 1 week and exposure to a column of fresh water under a 35-day retention time. By contrast, the oxygen demand of the B-horizon from the second study site was less than 120 mg $O_2/(m^2 \times day)$, suggesting that removal of the A-horizon could yield a fourfold improvement in the oxygen demand. Hence, prior to reservoir filling, the removal of all vegetation and/or the A-horizon would probably reduce the initial oxygen demand.

5.005 WES felt that blooms of blue-green algae were possible throughout the summer. The magnitude of these blooms would be similar to those of surrounding lakes. During large blooms, surface accumulation is probable.

5.006 State standards for fecal coliforms may be violated occasionally.

5.007 Proposed Twin Valley Lake would be eutrophic.

5.008 Both bottom and selective withdrawal met the downstream temperature objective. The in-lake water quality was also similar for both withdrawal schemes. Bottom withdrawal was recommended by WES.

5.009 A series of fillings and flushings prior to the initial filling of the reservoir followed by a period of incremental filling was suggested by WES as an approach to minimize the impact of flooding an area that contains large levels of organic matter in the A-horizon of its mineral soil. This procedure would improve water quality during the initial years of the impoundment.

5.010 The above recommendations by WES in regards to the clearing and filling activities in the proposed reservoir and bottom withdrawal will not be adhered to by the St. Paul District. Instead, the reservoir area will be cleared through the application of the procedures set forth in Engineer Regulation 415-2-1. This regulation states that all vegetation (i.e., timber and brush) 3 feet above and 5 feet below the conservation pool level (for Twin Valley, this level is at 1063 feet msl) will be removed. Also, trees within 1 mile of the main embankment and swimming areas will be cleared. The reservoir will be filled through a series of incremental stages, with each stage approximately 90 days apart. In addition, the Minnesota Pollution Control Agency has stipulated that the main embankment of the proposed dam should contain a multilevel outlet structure. Hence, in order to comply with this request, selective withdrawal capabilities will be provided through the incorporation of a multilevel withdrawal structure.

Table 1 A Listing of Existing and Proposed Substances or Characteristics and Their Limits or Ranges for the Wild Rice River Specified by MPCA in WPC 14

Substance or Characteristic	Existing Limits or Ranges	Proposed Limits or Ranges
Dissolved oxygen	Not less than 6 milligrams per liter from April 1 through May 31, and Not less than 5 milligrams per liter at other times.	Not less than 5 milligrams per liter at all times (instantaneous minimum concentration).
Temperature	5°F above natural in streams and 3°F above natural in lakes, based on monthly average of the maximum daily temperature, except in no case shall it exceed the daily average temperature of 86°F.	no change.
Ammonia (N)	1 milligram per liter.	0.04 milligram per liter (un-ionized as N).
Chromium (Cr)	0.05 milligram per liter.	no change.
Copper (Cu)	0.01 milligram per liter or not greater than 1/10 the 96 hour TLM value.	no change.
Cyanides (CN)	0.02 milligram per liter.	no change.
Oil	0.5 milligram per liter.	no change.
pH value	6.5 - 9.0.	no change.
Phenols	0.01 milligram per liter and none that could impart odor or taste to fish flesh or other freshwater edible products such as crayfish, clams, prawns, and like creatures. Where it seems probable that a discharge may result in tainting of edible aquatic products, bioassays and taste panels will be required to determine whether tainting is likely or present.	no change.
Turbidity value	25	no change.
Fecal coliform organisms	200 most probable number per 100 milliliters as a monthly geometric mean based on not less than 5 samples per month, nor equal or exceed 2000 most probable number per 100 milliliters in more than 10% of all samples during any month.	200 organisms per 100 milliliters as a logarithmic mean measured in not less than five samples in any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 400 organisms per 100 milliliters. (Applies only between May 1 and October 31).

Table 1 Cont'd A Listing of Existing and Proposed Substances or Characteristics and Their Limits or Ranges for the Wild Rice River Specified by MPCA in WPC 14

Substance or Characteristic	Existing Limits or Ranges	Proposed Limits or Ranges
Radioactive materials	Not to exceed the lowest concentration permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.	no change.
Chlorides (C)	250 milligrams per liter.	no change.
Hardness	500 milligrams per liter.	no change.
Bicarbonates (HCO_3)	5 milliequivalents per liter.	no change.
Boron (B)	0.5 milligram per liter.	no change.
Specific Conductance	1,000 micromhos per centimeter.	no change
Total dissolved salts	700 milligrams per liter.	no change.
Sodium (Na)	60% of total cations as milliequivalents per liter.	no change.
Sulfates (SO_4)	10 milligrams per liter, applicable to waters used for production of wild rice during periods when the rise may be susceptible to damage by high sulfate levels.	no change.
Hydrogen sulfide	0.02 milligram per liter.	no change.
Unspecified toxic substances	None at levels harmful either directly or indirectly.	no change.
Total Residual Chlorine	No limits given.	0.003 milligram per liter.

Table 2 Summary of Water Quality Data Taken at the USGS Gage at Twin Valley*

Variable	1975 Mean		1976 Mean		1977 Mean		Mean		Minimum Value	Maximum Value
Dissolved Oxygen (DO), mg/l	9.0	(5)**	9.6	(29)	9.4	(21)	9.5	(55)	6.1	13.4
Biochemical oxygen demand (BOD), mg/l	-		2.6	(18)	8.5	(18)	5.5	(36)	1.0	23.0
Total Phosphorus (P), mg/l	0.079	(7)	0.056	(31)	0.051	(24)	0.057	(62)	0.01	0.24
PO_4-P, mg/l	-		0.023	(29)	0.027	(20)	0.024	(49)	0.01	0.10
Total Soluble Inorganic Nitrogen (N), mg/l	0.23	(6)	0.074	(27)	0.119	(24)	0.11	(57)	0.0	0.[illegible]4
NO_3-N, mg/l	0.17	(6)	0.04	(28)	0.072	(24)	0.066	(58)	0.0	0.64
NH_4-N, mg/l	0.065	(6)	0.03	(29)	0.048	(24)	0.041	(59)	0.01	0.33
NO_2-N, mg/l	0.0	(6)	0.0	(28)	0.0	(24)	0.0	(58)	0.0	0.0
SiO_2, mg/l	14.9	(7)	12.6	(28)	13.6	(24)	13.3	(59)	1.5	22.0
Alkalinity, mg/l as $CaCO_3$	228	(7)	251	(30)	249	(24)	248	(61)	150	347
pH	8.0	(7)	8.2	(30)	8.3	(24)	8.2	(61)	7.3	8.8
Specific conductance, micromhos/centimeter	402	(43)	549	(173)	553	(254)	537	(461)	254	844
Total dissolved solids (TDS), mg/l	303	(7)	307	(26)	327	(24)	315	(57)	231	369
Fecal coliforms, colonies/100 ml	31	(4)	63	(25)	-		58	(29)	6	390
Total streptococci, colonies/100 ml	31	(5)	65	(24)	-		59	(29)	2	248

* From U.S. Army WES Technical Report EL-79, "Water Quality Evaluation, Proposed Twin Valley Lake, Wild Rice River, Minnesota."
** Number in parentheses is number of values used to calculate mean.

Table 3

Summary of NES Data

Lake Name	Storet No.	County	Distance, km, and Direction from Twin Valley	Lake Type[a]	Surface Area, ha	Mean Depth, m	Maximum Depth, m	Volume, 10^6 m^3	Mean Hydraulic Residence Time, yr	Conductivity Range, umhos/cm	Secchi Disc Depth Range, m	Stratification, [b]	Minimum DO, mg/l [c]	pH Range	Alkalinity Range, mg/l $CaCO_3$	N:P Ratio [d]	Limiting Nutrient [e]	Total Annual P Load, g/m²/yr	Accumulated Annual P Load, g/m²/yr	Total Annual N Load, g/m²/yr	Accumulated Annual N Load, g/m²/yr	[illegible] [f]	Trophic State [g]
Minnesota Lakes																							
Andrusia	27C0	Beltrami	122 ENE	N	611	7.9	18.3	48.4	0.13	240-345	1.1-1.5	11.6	0.3	7.0-8.5	136-183	8:1-40:1	U	4.02	1.17	59.1	6.9	11.[illegible]-17.4[illegible]	E
Badger	2704	Polk	50 ENE	N	143	1.2	3.4	1.75	0.30	450-485	1.3-2.4	--	10.2	8.4-8.5	183-185	7:1-17:1	U	0.63	--	10.6	0.03	0.9-[illegible]	E
Bartlett	2705	Koochi-ching	167 ENE	N	123	2.6	4.6	3.18	1.9	220-258	0.3-0.8	0.5	7.2	8.3-8.9	93-121	8:1-16.1	U	0.37	0.21	3.4	0.6	25.[illegible]-63.9[illegible]	E
Bemidji	27C1	Beltrami	104 ENE	N	2,598	9.8	23.2	253	0.73	290-380	1.8-2.5	9.8	0.2	7.3-8.4	149-183	9:1	N	0.44	0.16	13.4	3.3	6.6-[illegible]7.0[illegible]	E
Big Stone	2709	Big Stone	218 S	N	5,103	3.4	4.9	171	1.7	730-980	0.4-2.7	0.5	6.0	7.8-8.7	124-196	4:1	U	0.31	--	4.3	0.1	0.6-[illegible]	E
Birch	2710	Cass	135 ESE	N	519	3.1	13.7	15.8	--	150-265	1.4-4.3	12.0	0.3	6.5-8.7	88-129	2.5:1-24:1	N,P	--	--	--	--	1.[illegible]-[illegible].7[illegible]	E
Blackduck	2711	Beltrami	140 ENE	N	1,110	4.5	11.3	50	4.2	240-260	0.9-2.3	1.6	6.3	7.2-8.7	121-131	8:1-13:1	P	0.14	0.08	2.6	1.2	9.[illegible]-[illegible]5.7[illegible]	E
Blackhoof	2712	Crow Wing	193 SE	N	74	4.4	9.1	3.27	0.70	199-275	1.4-1.8	15.5	0.0	7.2-8.6	94-122	5:1-14:1	N	1.22	1.03	11.8	4.9	5.7-[illegible]9.6[illegible]	E
Carlos	27B9	Douglas	160 SSE	N	1,020	13.1	49.7	134	3.7	320-420	1.8-3.7	14.0	2.0	8.0-8.6	161-199	17:1	P	0.14	0.08	6.7	3.0	3.[illegible]-[illegible].4[illegible]	M
Cass	2715	Beltrami & Cass	130 ENE	N	6,312	7.6	36.6	481	0.86	248-330	1.1-3.1	14.9	0.04	7.2-8.5	132-175	7:1-28:1	U	0.35	0.22	8.8	1.6	3.2-[illegible].4[illegible]	M
Darling	27B4	Douglas	166 SSE	N	386	6.2	18.9	23.9	0.87	340-475	2.1-2.8	10.7	0.0	7.3-8.5	190-218	8:1-21.1	U	0.19	0.05	9.1	0.6	8.6-[illegible]9.2[illegible]	M-E
Gull (South Basin)	2737	Cass & Crow Wing	175 SE	N	3,861	9.1	34.8	353	2.9	187-220	2.0-3.0	13.0	0.0	7.0-8.6	93-123	6:1-16.1	N	0.10	0.04	3.7	1.4	4.5-[illegible].1[illegible]	E
Leech	2746	Cass	124 E	N	45,326	4.7	45.7	2141	5.2	239-310	1.7-3.0	10.2	1.0	7.3-8.4	129-154	5:1-14:1	N	0.04	0.02	2.4	1.2	3.[illegible]-[illegible].7[illegible]	M
Le Homme Dieu	27B5	Douglas	166 SSE	N	706	6.4	25.9	45.2	7.9	290-370	1.2-3.7	13.0	0.0	7.3-8.6	142-216	10:1-30:1	P	0.12	0.10	3.4	2.2	4.[illegible]-8.8[illegible]	E
Little	2748	Grant	140 S	N	28	--	1.2	--	--	325-825	0.4-2.0	--	7.1	9.0-9.4	190-296	1:1-8:1	N	--	--	--	--	5.[illegible]-[illegible]30	Hyper E
Malmedal	2752	Pope	190 SSE	N	79	1.8	2.4	[illegible].4	1.3	520-600	0.3-0.4	0.1	5.4	8.0-8.7	155-193	4:1-19:1	P	--	--	--	--	9.7-[illegible].5[illegible]	E
Minnewaska	2761	Pope	200 SSE	N	2,877	6.0	9.8	172	12.7	580-750	1.0-2.5	7.0	4.4	8.2-8.7	180-250	4:1-14:1	U	0.15	0.13	2.3	1.8	3.4-[illegible].9[illegible]	E
Rabbit	2771	Crow Wing	197 SE	N	215	7.2	15.2	15.5	--	255-300	1.5-3.7	14.0	0.0	7.2-8.6	102-131	4:1-24:1	U	--	--	--	--	2.[illegible]-[illegible].4[illegible]	E
Trace	2792	Todd	200 SE	N	112	--	--	--	--	--	0.9-1.2	--	8.7	8.1-9.6	154-206	--	--	--	--	--	--	1.[illegible]-[illegible]7.5[illegible]	E
Winona	27A1	Douglas	170 SSE	N	78	2.4	13.4	1.0	1.5	330-420	0.4-0.6	6.2	7.6	8.3-8.7	118-164	6:1-14:1	N	1.65	1.58	7.3	6.2	14.[illegible]-[illegible].7[illegible]	E
Wolf	27A2	Beltrami, Hubbard	120 ENE	N	425	8.5	17.7	36.3	0.10	248-355	0.8-1.5	12.9	0.4	7.2-8.7	137-169	3:1-12:1	N	6.43	0.80	60.3	--	12.[illegible]-2[illegible].9[illegible]	E

(Continued)

Table 3 (Concluded)

Lake Name	Storet No.	County	Distance, km, and Direction from Twin Valley	Lake Type[a]	Surface Area, ha	Mean Depth, m	Maximum Depth, m	Volume, 10^6 m^3	Mean Hydraulic Residence Time, yr	Conductivity Range, umhos/cm	Secchi Disc Depth Range, m	Stratification,[b]	Minimum DO, mg/ℓ[c]	pH Range	Alkalinity Range, mg/ℓ $CaCO_3$	N:P Ratio[d]	Limiting Nutrient[e]	Total Annual P Load, $g/m^2/yr$	Accumulated Annual P Load, $g/m^2/yr$	Total Annual N Load, $g/m^2/yr$	Accumulated Annual N Load, $g/m^2/yr$	Chlorophyll a[f] Range, μg/ℓ	Trophic State[g]
North Dakota Lakes																							
Astabula	3801	Barnes, Griggs	140 W	I	2,198	4.0	13.7	87.9	0.83	265-867	0.3-1.2	0.8	4.4	7.6-9.0	104-515	0.5:1-6:1	N	1.46	0.28	13.8	2.7	5.4-60.9	E
Jamestown River	3806	Stutsman	205 W	I	486	7.5	9.2	36.7	1.6	417-630	0.6-3.4	0.5	6.2	8.0-8.7	154-266	2:1-16:1	N,P	0.92	1.55	10.4	3.2	2.3-74.2	E
La Moure	3807	LaMoure	200 SW	I	200	5.0	12.2	9.96	1.9	333-733	0.8-3.7	8.4	0.0	7.6-8.4	128-515	1:1-4:1	N	1.35	0.56	5.2	0.7	2.6-39.2	E
Matejcek	3808	Walsh	180 NW	I	53	4.2	12.2	2.23	0.65	268-522	0.4-0.9	12.1	0.6	7.3-8.7	108-204	3:1-7:1	N	1.51	0.55	14.1	0.2	1.9-3.8	E
Spiritwood	3813	Stutsman	200 W	N	167	8.8	16.2	14.7	--	1720-2900	0.9-3.7	13.4	0.0	8.5-9.0	255-730	3:1-6:1	N	--	--	--	--	2.5-84.3	E
Whitman	3815	Nelson, Walsh	180 NW	I	58	2.7	7.7	1.57	0.7	263-520	0.5-0.9	2.1	5.8	7.6-8.9	96-238	0.5:1-8:1	N	0.83	--	9.2	--	3.5-77.2	E

a. Lake type - N corresponds to a lake of natural origin and I corresponds to a man-made lake (impoundment) created by impounding a stream or river.

b. Stratification - The strength of stratification is related to the maximum temperature difference between the surface and bottom waters.

c. Minimum DO - The minimum DO measured anywhere in the lake.

d. N/P ratio - The ratio of the mean in-lake nitrogen concentration (TSIN) to the mean in-lake dissolved phosphorus or orthophosphate concentration.

e. Limiting nutrient - Determined by the Algal Assay Procedure Test (EPA 1971). The symbol U indicates unknown.

f. Chlorophyll a - The J indicates that the values may be in error by ± 20 percent due to instrumentation problems in 1972.

g. Trophic state - Determined by comparing the measured phosphorus loading rate with those proposed by Vollenweider (1975). The symbols E, M, and O correspond to eutrophic, mesotrophic, and oligotrophic, respectively.

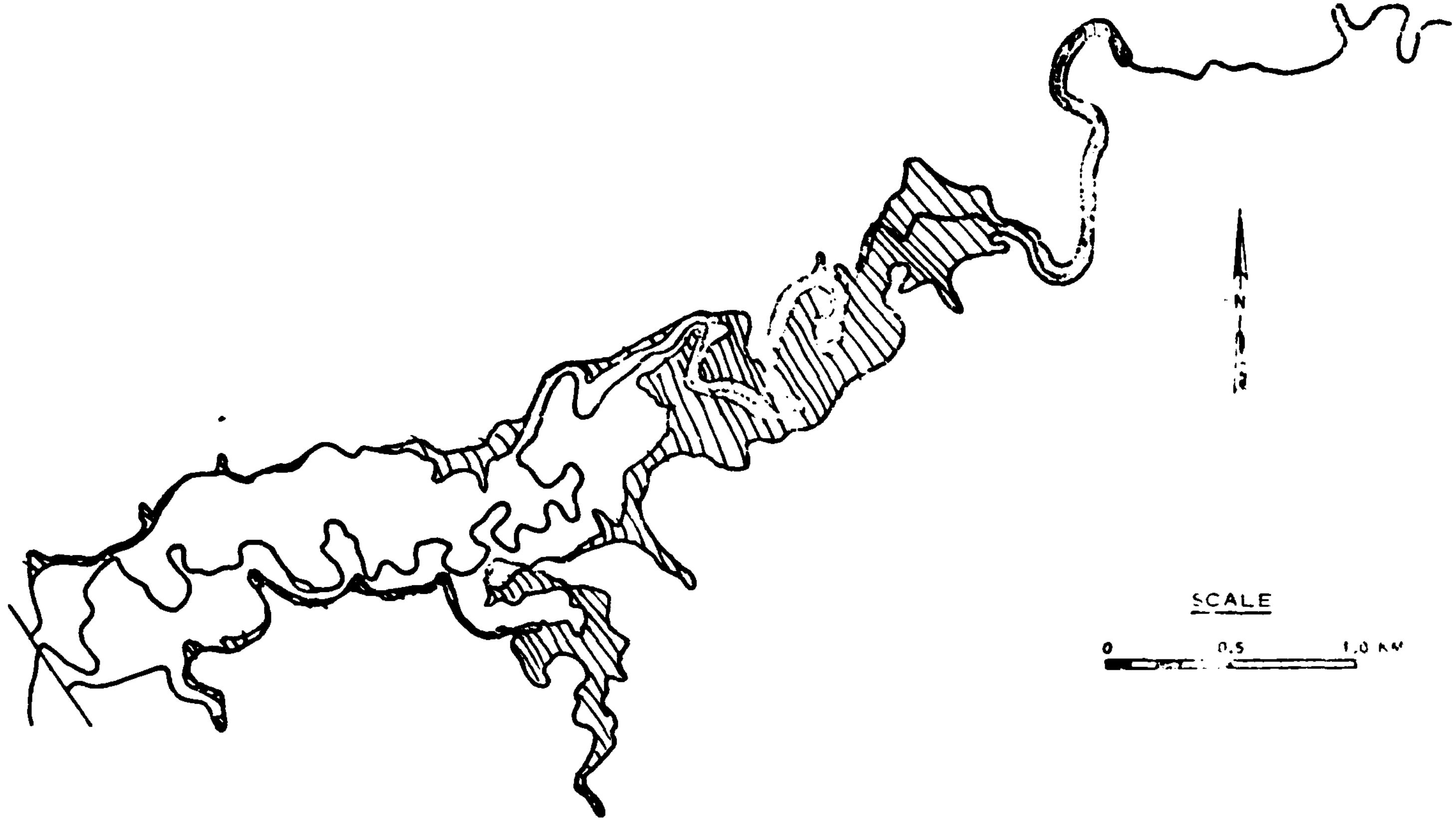


Figure 1. Potential Twin Valley Lake Aquatic Plant Areas

PART THREE:

SECTION 404(b)(1) EVALUATION

SECTION 404(b) EVALUATION OF
THE WILD RICE RIVER, TWIN VALLEY LAKE
FLOOD CONTROL PROJECT

The following is an evaluation of the proposed fill activities associated with the Twin Valley Lake Flood Control Project, in accordance with the requirements of Section 404(b) of the Clean Water Act of 1977.

1. PROJECT DESCRIPTION

The proposed project provides for the construction of an earthen-filled dam across the Wild Rice River approximately 1.5 miles upstream from Twin Valley, Minnesota. Some of the principal features of the dam include a low-flow outlet works, gated spillway, an overlook area, and recreational facilities. The proposed project would provide for the formation of a 52,200-acre-foot impoundment (7,500 acre-feet for recreation, conservation and silt retention and 44,700 acre-feet for flood control storage). The dam would have a top elevation of 1,116.0 feet (mean sea level) and a total crest length of 7,700 feet. The 1,200-foot main embankment across the river would have a maximum height of about 85 feet. Construction of the dam would require relocating County State Aid Highway 36 (CSAH) approximately 0.7 mile downstream from its existing alignment and raising CSAH 29 along its present alignment across Marsh Creek. A fishing pool would be developed below the stilling basin and several instream structures (such as wingdams, gabion structures, and artificial riffles) would be placed downstream of the main embankment for purposes of river fishery enhancement. (Refer to Figures 1, 2, and 3 for the location of the dam, CSAH 36 and 29, and the downstream fishing pool).

a. Description of the proposed discharge of dredged or fill materials

(1) General characteristics of material - Fill material for construction of the upstream and downstream cofferdams would consist primarily of clean sand. The remainder of the dam embankment would consist of a lacustrine sand and clay from an upland source, and alluvial sands and gravel excavated within the river valley.

Fill material to be used for the relocation of CSAH 36 and elevation of CSAH 29 would consist of materials similar to those found in the main embankment. Riprap and fill material for the downstream fishery enhancement structures would consist of quarried granite or fieldstone. Stone material used in the construction of gabion structures would be enclosed in a wire mesh basket anchored to the substrate.

(2) Quantity of material proposed for discharge - Approximately 1.37 million cubic yards (cys) of selected fill material would be required for construction of the main embankment (including the two cofferdams) and tie-back dikes. The relocation of CSAH 36 and elevation of CSAH 29 would require approximately 30,000 cys and 38,000 cys of fill material, respectively. The construction of the instream fishery improvement

structure for the downstream area would require approximately 1,200 cys of rock material.

(3) <u>Source of material</u> - Fill material required for construction of the upstream and downstream cofferdams would come from borrow sites A and B located in the upland area south of the left abutment (see Figure 3) and from the excavation site for the low-flow outlet works. Borrow site A is approximately 144 acres in size and lies east of the dam access road from CSAH 31. Borrow site B lies adjacent to borrow site A (west of the access road) and would be approximately 86 acres in size.

Materials for the relocation of CSAH 36 and elevation of CSAH 29 would come from the excavation activities associated with the relocation of CSAH 36. An existing gravel pit, located 2 miles south of CSAH 36, would be used as an alternate source of material if more is required. Quarried granite or fieldstone for riprapping and instream fishery structures would be obtained from one of the many existing sources within the Twin Valley area. The gabion wire mesh baskets would be obtained from a commerical source.

b. <u>Description of the proposed disposal site(s) for dredged or fill material</u>

(1) <u>Location</u> - The Wild Rice River basin is located in the northwestern portion of Minnesota, in Mahnomen, Norman, and portions of Clearwater, Becker, and Clay Counties. The river originates at Upper Rice Lake in Clearwater County and flows in a westerly direction for approximately 185 miles until it enters the Red River of the North. From the main embankment of the dam to the downstream takeline, several instream structures (gabions, wing dams, and artificial riffles) would be placed within the existing river channel and would either completely or partially cross the river. Cofferdams would be constructed just upstream and downstream of the main embankment to divert stream flows. The upstream cofferdam would form the upstream toe of the dam while the downstream cofferdam would become the riprapped embankment slope of the disposal area at the downstream toe of the dam. Below the downstream cofferdam, a fishing area would be developed. This downstream fishing area would be 50 feet wide and 100 feet long with a maximum depth of 10 feet. At approximately river mile 71, fill material would be placed across the river channel for the relocation of CSAH 36. At approximately 3 or 4 miles upstream from the commencement of Marsh Creek (river mile 72 on the Wild Rice River), fill material would be placed over the existing alignment of CSAH 29. (Refer to Figure 2 for the location of the proposed fill sites.)

(2) <u>Type of disposal sites</u> - Two cofferdams consisting of compact sand would be placed across the river in order to divert stream flows through the low-flow outlet works. The cofferdams would ultimately form the upstream and downstream toe of the main embankment. The relocation of CSAH 36 would involve side-channel reshaping and the placement of fill material across the river channel approximately 0.7 mile downstream from its existing alignment. A corrugated metal pipe (cmp) or concrete culvert would be placed beneath the fill material in order to accommodate the impounded floodwater. CSAH 29 would be raised along its present alignment

with the replacement of its existing culverts. Quarried granite or fieldstone would be placed within the existing channel at several locations downstream of the dam. This material would form the fishery enhancement structures (gabions, wing dams, and artificial riffles) and the riprap lining on the downstream fishing pool just below the stilling basin. The exact locations of the fishery enhancement structures would be determined during future studies. However, their intended purpose is to preserve the deeper pool areas immediately upstream of the major bends below riffle areas of the river (for example, note Figure 1 - points A to E).

(3) Method of discharge - Construction of the upstream and downstream cofferdams would be accomplished by dumping fill material (sand) into the river channel and shaping it with a bulldozer or grader. Backfilling of cmp's or concrete box structures would be done by a grader or other suitable equipment. The instream structures and riprap materials for the downstream fishery enhancement structures would be hauled in by truck and placed within the river channel by means of a crane equipped with a bucket and/or other similar equipment.

(4) When will disposal occur? - Disposal of all fill material would occur during the 1984 through 1988 construction seasons.

(5) Projected life of disposal sites - The life expectancy of the main embankment, including the cofferdams, has been estimated to be 100 years. The instream fishery structures would last for approximately 50 years or more and the fishing pool would last for the life of the project.

(6) Bathymetry - Construction of Twin Valley Dam would convert a relatively shallow free-flowing stream into a reservoir-type environment. Once filled, the reservoir would collect most of the suspended sediments that would normally be washed downstream. In time, the reservoir would begin filling in, starting with the upstream reaches and progressing downstream toward the main embankment. Downstream of the dam, reduced sediment loads would increase the erosion capability of the stream flow during low-flow periods. This would result in channel modification for some distance downstream of the low-flow outlet works. Instream structures, by their design, would force the river current toward the center of the channel, producing scour holes beneath them. Bridge construction on CSAH 29 and 36 would not have an adverse effect on the bathymetry of Marsh Creek and the Wild Rice River; however, some scouring is expected immediately downstream from these structures.

2. PHYSICAL EFFECTS (40 CFR 230.4-1(a))

a. Potential destruction of wetland-effects on (40 CFR 230.4-1(a)(i)(i-vi))

(1) Foodchain production - Construction of Twin Valley Dam and its associated structures would have an adverse effect on both the terrestrial and aquatic foodchain production in that portion of the Wild Rice River which forms the conservation pool area, and to a lesser extent, the flood pool and downstream areas. Within the aquatic environment of the impoundment area, many organisms that form the existing foodchain may be eliminated due to their inability to survive within this type of environment. However, with biological aging and nutrient enrichment, the reservoir would develop a community of aquatic organisms normally associated with an enriched environment. Some of these organisms would replace, in the foodchain, those species which were initially lost from the riverine community. The development of the reservoir would also have an effect on the downstream running water system. The permanent pool would serve as a trap for most of the normal stream drift material (mostly immature aquatic insects and amphipods) which provide a forage base for the downstream fishery.

This initial effect could be offset through the development of plankton communities within the reservoir. These organisms could be swept through the outlet works and be added to the downstream drift material. The deeper pool areas (i.e., those below the fishery structures) in the downstream area would also contribute to the forage base for the existing fishery. The length of the river which would be affected by the loss of the drift material is uncertain at this time. As previously mentioned, the terrestrial foodchain communities existing within the project area would also be adversely affected. Those species forming the lower portion of the foodchain would be most seriously affected due to their inability to escape inundation. In time, the larger and more mobile species would be widely displaced. Following project completion, some of those species initially displaced would become re-established while those that were permanently displaced would be replaced by other species requiring similar habitats. It will probably take several years for a well developed foodchain to develop in the project area.

(2) General habitat - Fill activities (i.e., cofferdam and main embankment) within the Wild Rice River would provide for the impoundment of the normal stream flow and floodwater retention. Accompanying this impoundment, an immediate retardation of the river's current and the dropping of its sediment load is expected. Significant changes in temperature relationships, light transmission, gas chemistry, and solute equilibria are also expected. These factors would not only affect those species within the reservoir but also those found within the downstream reaches of the river. In the reservoir area, approximately 540 acres of riparian woodland and stream habitat would be lost and an additional 1,100 acres of riparian and upland habitat would be modified as a direct result of project activities. In the downstream area, the flow rate and its associated suspended particulate material would be reduced. As a result, erosive activities would increase during low flows and decrease during high-flow periods. The existing forest communities within the downstream reaches would begin to show a gradual shift from flood-tolerant species to those found in drier areas and hence less tolerant of frequent inundation. The formation of the fishing pool and instream structure would provide habitat for the river fishery which would be lost due to the reduction of stream flows and annual river flooding. Both vertebrate and invertebrate species would benefit from these structures.

(3) Nesting, spawning, rearing, and resting sites for aquatic or land species - With construction of Twin Valley Dam, spring migration of fish (walleye, sauger, northern pike) would be impeded. Downstream nesting, spawning, rearing, and resting areas would become severely restricted due to reduced flows in that area. By their design, instream structures would provide some habitat for the above-mentioned species. However, these structures in themselves would guarantee neither an increase in their production nor their survival. Those species (large and small-mouth bass, northern pike, walleye, bluegill, and perch) associated with the reservoir should be able to find suitable habitat within the confines of the reservoir or within the upstream reaches of the river. The movement of reservoir species into upstream areas may enhance the fishery value of certain stream pools. Terrestrial wildlife populations within the reservoir area would be significantly affected. Those species (such as amphibians, reptiles, small mammals, and birds) normally associated with the habitat currently found along the river would either migrate from the area or be eliminated. Although most of the true woodland bird species would be displaced, those species frequenting forest-edge or water-edge areas would likely increase. Some of these species could be replaced by close relatives having less restrictive habitat requirements. Waterfowl populations may increase in the area due to an increase in shoreline habitat. Although other species (such as deer and grouse) would tend to migrate from the valley to the uplands, their overall population would still tend to decline due to the unavailability of suitable habitat in upland areas surrounding the reservoir.

(4) Those set aside for aquatic environment study or sanctuaries or refuges - Not applicable: there are no areas set aside for aquatic environment study or sanctuaries or refuges which would be affected by fill activities associated with the Twin Valley Lake Project.

(5) Natural drainage characteristics - The Wild Rice River begins in Upper Rice Lake in Clearwater County and flows through Lower Rice Lake approximately 20 miles downstream. The river then begins to flow in a westerly direction until it joins the Red River of the North approximately 30 miles north of Moorhead, Minnesota. The overall length of the river is about 185 miles. Its principal tributaries are the White Earth River, Marsh Creek, South Branch Wild Rice River, and Felton Creek (Ditch), with drainage areas of 202, 154, 253, and 144 square miles respectively. The natural drainage area for the Wild Rice River would not be significantly affected by the placement of a dam upstream of Twin Valley, Minnesota. Flows to the downstream area would be reduced somewhat during normal discharge periods, and those during maximum discharge periods would be delayed. The dam would reduce the amount of land inundated by a given flood event. Thus, the overall damages to agricultural, commercial, and residential property would be reduced.

(6) Sedimentation patterns - Sedimentation patterns in the Wild Rice River would be modified by the construction and formation of Twin Valley Dam and Lake. The reservoir would essentially form a sediment "trap." For Twin Valley Lake, 7,500 acre-feet of storage is provided for sediment trapped during the 100-year life of the project. The rate of sedimentation would ultimately depend on the completeness of erosion control in the watershed and the extent of shoreline slumping. Because some of the sediments, particularly in the larger particle sizes, would be trapped behind the dam, downstream reaches of the Wild Rice River would have a reduced sediment load. The reduced load would give the river greater capacity for scour during low-flow periods than currently exists. Erosion of the river bank and bed at downstream locations would then increase under low-flow conditions and decrease during floods.

(7) Salinity distributions - Not applicable: fill activities would not have an effect on salinity distributions.

(8) Flushing characteristics - The flushing characteristics of the Wild Rice River would be significantly affected by fill activities associated with construction of Twin Valley Dam. Twin Valley Lake would exist as a sediment trap, retarding the normal flow of sediments and nutrients to the downstream reaches of the river. Upon entering the reservoir, the mean residence time would be approximately 21 days (mean monthly residence time would vary from 7 days in April to 47 days in September). As a result, the reservoir would become shallower and eutrophic due to sediment and nutrient accumulations. Given a lengthy development time within the reservoir, plankton populations would likely become quite abundant and diverse. The reservoir would reduce the overall flow rate downstream from Twin Valley to its junction with the Red River of the North. The greatest reduction in flow rates would occur during maximum discharge periods (i.e., April through June) which would result in smaller amounts of land being inundated in any given flood event. Bridge construction for CSAH 29 and 36 would not have an adverse effect on the flushing characteristics of the rivers which they cross.

(9) Current patterns - The current in the Wild Rice River moves at a relatively slow rate (usually less than 0.8 ft/sec), accelerating in the riffle areas and slowing in the deeper pool areas. In the Twin Valley area, the current tends to accelerate slightly due to an increase in the gradient of the river. Twin Valley Dam would alter existing current patterns in the Wild Rice River. Upon entering the reservoir, the current would be immediately reduced, forcing the river to drop its suspended sediment load and other materials within the water column. For some distance downstream of the dam, the current would begin to accelerate, ultimately achieving its normal flow rate of about 0.8 ft/sec. Instream structures below the dam would be used to accelerate the current and provide fishery habitat.

(10) Wave action, erosion, or storm damage protection - Seasonal raising and lowering of the reservoir for floodwater retention and the effects of rain and wave action upon the shoreline are expected to cause some slumping and erosion of the steep valley walls. Although the extent of erosion and slumping is not expected to be significant, some unstable areas could occur. Riprapping the main embankment 5 feet below the conservation pool level would prevent any serious erosion from occurring in this area. Twin Valley Dam would provide some protection against inundation to those agricultural, commercial, and residential properties existing downstream of the dam. Although inundation would not be totally prevented as such, the degree and duration of a potential flood event would be reduced.

(11) Storage areas for stormwaters and floodwaters - Fill activities associated with the proposed project would not adversely affect those areas which currently serve as storage areas for stormwaters and floodwaters. However, once completed, the project would serve as an area for the storage of stormwaters and floodwaters. The reservoir impounded by the dam would provide 52,200 acre-feet of controlled storage (7,500 acre-feet would be used for recreation and silt retention and 44,700 acre-feet for floodwater storage).

(12) Prime natural recharge areas - The water table at the proposed project site is presently at river level. Modifications to groundwater levels may occur when the permanent conservation pool is filled and could, in turn, have some effect on vegetation in the immediate vicinity of the conservation pool. A slight rise in the groundwater table to the west and downstream of the dam site is expected. Groundwater levels adjacent to the reservoir would not be significantly affected by intermittent floodwater storage because the time required for the water table to adjust to the temporary increase in water level would be greater than the duration of floodwater storage. Significant changes to the groundwater level as a result of the relocation and elevation of CSAH 36 and 29, and of the placement of instream structures in the downstream area are not expected to occur.

b. Impact on water column (40 CFR 230.4-1 (a)(2))

(1) Reduction in light transmission - During construction of the cofferdams and hence the main embankment, and in the relocation and elevation of CSAH 36 and 29, increases in suspended sediment levels downstream of the construction area are expected. Increases in suspended sediments would decrease the amount of light that would normally be transmitted through the existing water column. Those populations (principally planktonic forms) dependent upon light would be adversely affected. Within the reservoir, runoff from snowmelt and periods of heavy rainfall would increase turbidity levels in some areas, reducing light transmission and affecting both plankton and plant populations within those areas.

(2) Aesthetic values - The Wild Rice River, as previously noted, does not have a well developed algae and plankton population. However, occasional algal blooms have occurred within the riffle areas of the river. With the filling of the reservoir, the initial limitations placed on these populations would be removed and their productivity would increase. During major algal blooms, large mats of algae could develop on the water surface, and the accumulation of such mats along the shoreline would present an aesthetically displeasing appearance. The unpleasant odors which sometimes occur during periods of decay would also affect the aesthetic qualities of the project area. Erosion of the shoreline areas from runoff and pool level fluctuations would also reduce the attractiveness of the shoreline by producing denuded areas of vegetation and clouding of the adjacent water. Inclusion of a multi-level outlet structure, downstream fishery improvement structures, and a stilling basin would aid in reducing the adverse impacts and increasing the aesthetic qualities of the water column within the downstream reach of the river.

(3) Direct destructive effects on nektonic and planktonic populations - Construction of Twin Valley Dam and Lake would have a profound effect on both the nektonic and plankton populations which presently inhabit the riverine environment. The dam would serve as a formidable barrier to those species that normally migrate upstream for spawning and foraging purposes while at the same time it would prevent the normal stream drift material from reaching downstream areas. Those species trapped within the confines of the reservoir would either survive or be replaced by other species capable of surviving in a reservoir environment. The reservoir should provide a good forage base for those species initially trapped in the impoundment. Some species may forage upstream of the reservoir, temporarily enhancing that portion of the river.

Plankton and nekton populations should become well developed in the reservoir. On occasion, nuisance plankton blooms would be expected as the reservoir ages and becomes enriched with nutrients. Releases from the reservoir, to the downstream area, should not adversely affect nekton and plankton populations in this area.

c. Covering of benthic communities (40 CFR.4-1 (a)(3))

(1) Actual covering of benthic communities - Cofferdam construction, relocating and elevating CSAH 36 and 29 (respectively), and the placement of instream structures would have an adverse effect on the existing benthic communities. Those benthic communities existing within the 1,200-foot section between the upstream and downstream cofferdams would be permanently lost from the river's aquatic ecosystem. Construction activities associated with both CSAH 36 and 29, and the placement of instream structures downstream of the main embankment would bury those species unable to migrate from the area while mobile species would be temporarily displaced. After construction is completed, these areas would provide suitable habitat for benthic communitie preferring a more stable substrate.

(2) Changes in community structure and function - Benthic communities disturbed or destroyed by fill activities would be replaced by a community of organisms normally associated with a lake-type environment. These new communities, although containing different individuals, would have a similar function and structure as their predecessors. Within the confines of the reservoir, two different communities having similar functions would develop. The benthic-littoral (shallow water) community would consist of such species as mayfly, dragonfly, and damselfly larvae, leeches, crayfish, clams, snails, and an abundance of microscopic plants and animals. The benthic-limnetic (open water) zone would consist of a few detritus feeders, namely midges, fingernail clams, and a few protozoans. These two communities would be significantly different from the stream communities they have replaced.

d. Other effects (40 CFR 230.4-1 (a))

(1) Changes in bottom geometry and substrate composition - Bottom geometry and substrate composition would not be appreciably changed within the upstream and downstream reaches of the Wild Rice River channel. Charges to the substrate would occur only in those areas where structures (gabions, artificial riffles, wingdams, and cmp culverts for the bridge structures on CSAH 36 and 29) are actually placed within the channel. In these areas, a relatively sandy-gravel substrate would be overlaid by either riprap materials or some other suitable fill material.
The greatest changes would occur in the areas encompassing the main embankment and the conservation pool of the reservoir. Twin Valley Dam would cover approximately 1,?00 feet of the existing river channel. Fill material for this structure would consist primarily of lacustrine sand and clay obtained from two upland borrow sites. The existing river channel, for approximately 7 river miles upstream from the dam, would be converted to a standing-water type of environment. In time, most low-lying areas that existed along the river channel, including the channel itself, would be filled in through the accumulation of sedimentary materials brought in through runoff, shoreline slumping and erosion, and from upstream reaches of the river. Sedimentary materials would consist of lacustrine fine sands and silts and some alluvial sands and gravel. Thus, throughout the life of the project, the bottom geometry and substrate composition of the conservation pool would continue to change during its filling process.

(2) Water circulation - The tumbling and churning motion of the water column within the Wild Rice River would be dissipated upon entering the upper end of the conservation pool. Once in the pool, circulation would principally be brought about through wind-generated currents moving across the surface of the reservoir. For the most part, the entire water column should circulate throughout the year; however, a potential for thermal stratification does exist. If thermal stratification should occur, mixing of the upper, well-oxygenated layer with the bottom layer of the reservoir water column would be inhibited. If wind velocities are strong enough during periods of thermo-stratification, this layering effect of the water column could be overcome, resulting in complete reservoir circulation. Spring and fall are the two times of the year when complete circulation within the reservoir would have the least resistance. Normal stream flows to the downstream area would be reduced as a result of damming the river. The placement of structures within the existing river channel would accelerate these low outflows. Circulation would be improved, reducing the degrading effects that reservoir outflows would have on the immediate area downstream from the dam.

(3) Salinity gradients - Not applicable: placement of fill material within the Wild Rice River and subsequent formation of Twin Valley Lake would not have an adverse effect on salinity gradients.

(4) Exchange of constituents between sediments and overlying water with alterations of biological communities - Fill material would not contain constituents that would affect the underlying substrate and overlying water column. Effects on biological communities would not be significant. However, there would be a possibility of an exchange of nutrients between the soils within the river valley and the overlying water column as a result of impounding the Wild Rice River. Following inundation, the river valley substrate would release both organic and inorganic forms of nitrogen, phosphorus, carbon, sulphur, and lesser amounts of manganese and iron into the overlying water column. As oxygen levels decrease in the bottom layer of the reservoir (generally due to organic decomposition), many of the organic forms would be converted to their inorganic counterparts and would be readily available for absorption by plant communities within the reservoir. Aquatic life could be adversely affected by reduced oxygen levels. Levels of pH would remain moderate, due to the high buffering capacity of the inflowing water. Reservoir releases to the downstream area could be detrimental to many life forms, due to nutrient enrichment and potential reduced oxygen levels. Outflows from a multi-level outlet works could reduce this adverse effect to some extent. Nutrient enrichment of the reservoir from organic decomposition is expected to last only a few years following initial inundation.

3. CHEMICAL-BIOLOGICAL INTERACTIVE EFFECTS (40 CFR 230.4-1 (b))

a. Does the material meet the exclusion criteria? - The exclusion criteria state that dredged or fill material may be excluded from this evaluation if it is composed predominantly of sand, gravel, or any other naturally occurring sedimentary material with particle sizes larger than silt, characteristic of and generally found in areas of high current or wave energy such as streams with high bedloads or coastal areas with shifting bars and channels. The fill material to be used for this project

would meet these standards. Fill material would consist of sand, quarried rock or fieldstone, or any other naturally occurring sedimentary or glacial material with particle sizes larger than silt, generally found in areas having high current or wave energy. The fieldstone would be of glacial origin.

4. DESCRIPTION OF SITE COMPARISON (40 CFR 230.4-1 (c))

a. Total sediment analysis - A sediment analysis has not been performed on fill material to be used for dam construction because the material will be obtained locally and will consist of naturally occurring sedimentary material having particle sizes larger than silt. A sediment analysis was, however, performed on the valley substrate which would form the benthic zone for the proposed reservoir. This analysis has shown that the substrate contains an abundance of organic material which will release organic and inorganic forms of nutrients into the water column following inundation.

b. Biological community structure analysis (40 CFR 230.4-1 (c)(2)) - Within the project area, the Wild Rice River contains two basic habitat types, pools and riffles. Pool areas can be divided into shallow or deep zones having fine sand, silt, and/or clay substrates. Riffle areas are generally shallow, with substrates composed of larger stone material. Rooted aquatic plants are basically non-existent in this stretch of the river. The two previously mentioned habitat types may support some or all of the following plant and animal groups: green algae, diatoms, insect larvae, fingernail and unionid clams, minnows, suckers, sauger, walleye, northern pike, and rock bass. Algae and plankton populations are poorly developed within the river, although periodic blooms do occur. Cofferdam construction would eliminate approximately 1,200 feet of the existing river channel along with its biotic communities. Fill activities associated with the two CSAH bridges and fishery structures would temporarily displace some benthic communities. Damming the Wild Rice River would convert a relatively shallow, free-flowing river into a lake-type environment. Riverine communities unable to survive within the confines of the reservoir would be replaced by individuals more characteristic of a reservoir environment. After several years of aging, three biotic communities would become established within the reservoir: (1) limnetic (open-water), (2) benthic (bottom), and (3) littoral (shallow water). The littoral zone would be relatively warm, with an abundance of light and oxygen. A diversity of plant and animal species would be characteristic of this area (i.e., numerous insect larvae, algae, and plankton forms, rooted and floating aquatic plants, several fish species, clams, leeches, reptiles, and amphibians). The limnetic zone would be similar to the littoral zone in that it would be well oxygenated, relatively warm, and have a high degree of light penetration. Algae and plankton populations would be most abundant, with smaller communities of copepods, aquatic insects, rotifers, cladocera (water fleas), protozoans, and some fish species. The benthic zone would be predominantly dark, cool to cold, with seasonal fluctuations in oxygen and chemical levels. The principal species inhabiting this area would consist of a few detritus feeders, some insect larvae, fingernail clams, and a few protozoans.

5. REVIEW APPLICABLE WATER QUALITY STANDARDS

a. Compare constituent concentrations - Fill materials, due to their poor biodegradability and non-liquid nature, would not significantly alter the water quality of the Wild Rice River. The soils in the proposed impoundment area contain a relatively high concentration of organic and inorganic material (i.e., carbon, nitrogen, phosphorus, sulfides, iron, and manganese) which, when inundated, could pose a problem to the water quality of the reservoir. With inundation, there would be an immediate reduction in the dissolved oxygen concentration within the deeper areas of the lake. Under anaerobic conditions, the existing chemical constituents of the substrate would be subject to biological reduction and released into the overlying water column. This initial degradation would not only affect the upper layers of the reservoir but also the area immediately downstream from the dam if releases were made from a bottom outlet.

b. Consider mixing zone - As previously stated, due to the poor biodegradability and non-liquid nature of fill material, no significant degradation of water quality would occur during actual construction.

c. Based on a and b above, will disposal operation be in conformance with applicable standards? - Disposal of fill material into the Wild Rice River would be in conformance with applicable water quality standards due to the low biodegradability and non-liquid nature of the material. The proposed Twin Valley Lake is not expected to exceed applicable standards for water quality for impoundment areas. However, on occasion, the fecal coliform counts in the river have exceeded State standards of 200 colonies/100 ml. Periodic violations may occur after impoundment.

6. SELECTION OF DISPOSAL SITES (40 CFR 230.5) FOR DREDGED OR FILL MATERIAL

a. Need for the proposed activity - In the lower Wild Rice River basin, extensive flooding of agricultural land is a major water resource problem. As the stream emerges from the escarpment area of the basin, stream gradients decrease and channel capacities are reduced, causing floodwaters to escape the channel and move overland, inundating thousands of acres of highly productive cropland. The extent of losses resulting from a particular flood is dependent on the season of its occurrence and on the amount and timing of precipitation following the flood. During a normal flood event, approximately 69 percent of the flood-related damages are to crop and other agricultural lands; 24 percent to urban areas; and 7 percent to public land, roads, and bridges. With construction of Twin Valley Lake, the average annual flood-related damages along the Wild Rice and Marsh Rivers would be reduced by 64 percent over the project life. The dam would provide for the storage of 7,500 acre-feet of water for recreation, conservation, and silt retention with an additional 44,700 acre-feet for the floodwater storage.

b. Alternatives considered - Fourteen other alternative actions and a no action alternative were considered. Of the 14 alternatives, 6 were nonstructural and 8 structural. The 6 nonstructural alternatives (i.e., Flood Warning and Emergency Protection; Permanent Floodplain Evacuation; Floodproofing; Flood Insurance; Floodplain Regulation; and a Combination of Floodplain Evacuation, Floodproofing, and Floodplain Regulation) would

do little to lessen agricultural and urban flood damages in the basin. The 8 structural measures included the following activities: (1 & 2) channel modification of the Wild Rice or Marsh River, (3) levee and floodway system, (4) 18-mile diversion system, (5) a series of 8 small reservoirs on upstream tributaries, (6 & 7) Twin Valley Dam plus a series of small reservoirs or channel modification, and (8) Twin Valley Dry Dam. Since four of the eight structural alternatives (numbers 2, 3, 4, and 5 from above) would not significantly reduce the percent of flood-related damages within the basin and would have significant adverse economic and environmental effects, they were not considered viable alternatives. Structural alternatives 1, 6, and 7 were eliminated due to their significant adverse economic and environmental effects even though they would provide a reasonable degree of flood damage reduction. Twin Valley Dry Dam (structural alternative 8) would provide reductions in flood-related damages similar to those of the proposed project. However, it would have a greater environmental impact and would not provide any recreational benefits.

c. Objectives to be considered in discharge determination (40 CFR 230.5 (a))

(1) Impacts on chemical, physical, and biological integrity of aquatic ecosystem (40 CFR 230.5 (a)(1)) - Fill activities associated with the placement of instream structures in the downstream area and in the relocation and elevation of CSAH 36 and 29 would not significantly alter the chemical, physical, and biological integrity of the aquatic ecosystem. Fill material for the construction of cofferdams would permanently displace approximately 1,200 feet of the existing channel. Aquatic organisms not able to move out of the way would be buried. With completion of the main embankment, a free-flowing stream would be converted into a reservoir-type environment. The reservoir would inhibit the normal stream drift and serve as a sediment trap. In time, the reservoir is expected to become highly eutrophic. With aging, three biological communities should begin to develop within the reservoir: (1) limnetic (open water), (2) littoral (shoreline), and (3) benthic (bottom). Releases from the reservoir are expected to be high in nutrient content and poorly oxygenated and would have an adverse effect on the chemical and biological integrity of the aquatic ecosystems in the downstream reaches of the river.

(2) Impacts on foodchain - The placement of an earthen-filled dam across the Wild Rice River would disrupt its existing foodchain, principally the source of forage material, until suitable sources are developed within the reservoir. Twin Valley Dam would eliminate approximately 1,200 feet of the river channel, including those organisms unable to migrate from the area. The reservoir would essentially form a trap for the normal river drift which is used as a forage base by many aquatic communities. With aging, three distinct communities would develop within the reservoir (i.e., limnetic, littoral, and benthic zones) with each community containing a high diversity of plant and animal species serving as producers and consumers. Algae and plankton communities heretofore poorly developed within the river would become quite abundant within the reservoir. Arthropods are also expected to become quite abundant within the reservoir. This community could augment the forage base in the downstream reaches through outflows from the reservoir. Fill associated with

the relocation and elevation of CSAH 36 and 29 and with the placement of river and fishery improvement structures within the immediate area downstream from the dam would temporarily disrupt the existing foodchain for the duration of construction activities. Once completed, it is expected that recolonization by a different and more diversified community would occur.

(3) Impact on diversity of plant and animal species - The initial impact of fill material on the diversity of plant and animal species would not be significant. Algae, plankton, and rooted aquatic plant species are not currently abundant within the river. Benthic invertebrate and fish species are also not well developed; however, spring runs of northern pike, walleye, and sauger do occur. The formation of Twin Valley Dam would inhibit the movement of fish upstream beyond Twin Valley, reducing their relative abundance and diversity in that section of the river. As previously mentioned in other sections of this evaluation, Twin Valley Lake would contain three main communities: (1) benthic, (2) littoral, and (3) limnetic. Plant and animal resources of each of these communities would be highly diversified. The shoreline area would be composed of a variety of floating and emergent vegetation, algae, plankton, benthic organisms, leeches, clams, and fish species. The limnetic zone would be composed predominantly of plankton and some fish species while the benthic zone would consist of detritus feeding insect larvae and protozoans. Some of the reservoir fish species may migrate upstream, temporarily enhancing the fishery resource of that area.

(4) Impact on movement into and out of feeding, spawning, breeding, and nursery areas - The main embankment of the dam would serve as a barrier to migrating fish within the Wild Rice River. This barrier would prevent the annual spring migration of northern pike, walleye, and sauger up the river to their spawning areas north of Twin Valley. The formation of pools and riffle areas below the dam would provide some habitat; however, they would not by their design provide suitable spawning and nursery areas. One of the principal sources of forage material within the riverine environment comes from the normal stream "drift." With construction of the dam and reservoir most of this material will be eliminated from the downstream forage base. The reservoir would, however, become populated with a variety of plankton lifeforms which could be added to the downstream drift material, offsetting the initial effect to some extent. The reservoir should provide sufficient feeding, spawning, breeding, and nursery areas for those species contained within its boundaries. Some fish may forage upstream which would temporarily improve some of the pools in that area.

(5) Impact on wetland areas having significant functions of water quality maintenance - Not applicable: the proposed fill activities and development of Twin Valley Lake would not have an adverse effect on wetlands which help to maintain water quality within the river basin.

(6) Impact on areas that serve to retain natural high waters or floodwaters - Fill activities associated with the proposed project would not alter those areas which presently serve to retain natural high waters or floodwaters. The principal function of Twin Valley Dam and Reservoir would be to retain and delay potential floodwater. The reservoir would prevent approximately 63 percent of the potential flood related damages to urban and agricultural properties that would normally occur during a

flood event.

(7) Methods to minimize turbidity - Increases in turbidity levels are expected to be significant during the construction phase of the project. In order to reduce this potential impact, fill activities would be scheduled during low-flow periods. Riprap material would be placed adjacent to the stilling basin within the fishery pool area to prevent scouring of the existing river channel and on the up-and downstream surfaces of the main embankment and bridge structures. Areas subject to erosion which are not riprapped would be seeded with native grasses. The entrapment potential of the reservoir would prevent most sediments from being washed downstream.

(8) Methods to minimize degradation of aesthetic, recreational, and economic values - Development of Twin Valley Lake would, for the most part, eliminate the aesthetic qualities of the riverine environment within the project area. Associated with this loss would be a decline in the economic and recreational benefits that would normally occur in a river environment. The reservoir clearing plan calls for the removal of trees to a level of 5 feet above the recommended conservation pool. When filled, the wooded area surrounding the lake would be aesthetically pleasing. The reservoir would have a surface area of approximately 540 acres to be used for such purposes as fishing, swimming, and boating. Other project-related developments would be the formation of the recreation areas, one each on the north and south sides of the lake, for purposes of boating, camping, swimming, and picnicking. Both sites would contain boat-launching facilities. An overlook area would be maintained on the south abutment for sightseeing purposes. Downstream of the dam, a fishing access with a parking area would be provided in conjunction with the low-flow outlet works. In the downstream reaches, below the dam, a variety of instream structures would be placed to enhance the fishery resource of the river. A nature trail would be developed between the north recreation area and the Heiberg Dam located approximately 4 miles downstream. The Minnesota Department of Natural Resources (MDNR) has indicated an interest in managing the fish and wildlife resources on project lands. Without management, the reservoir fishery would significantly decline after several years, due to the eutrophication process that would occur within the lake. Section 6.c. (7)defines other methods that would be used to minimize the degradation of aesthetic values in the project areas.

(9) Threatened and endangered species - Not applicable: the proposed fill activities and reservoir development would not have an adverse effect on any known threatened or endangered species in the project area.

(10) Investigate other measures that avoid degradation of aesthetic, recreational, and economic values of navigable waters - All fill activities would be accomplished in a manner that would minimize their effects on the aesthetic, recreational, and economic value within the Twin Valley area (also see Sections 6.c.(7) and (8)).

d. Impacts on water uses at proposed disposal sites (40 CFR 230.5 (b) (1-10))

(1) Municipal water supply intakes - Not applicable: fill activities would not have an adverse effect on the municipal water supply intakes in the Twin Valley area.

(2) Shellfish - The Wild Rice River watershed provides suitable habitat for a large variety of unionid clams and other shellfish populations. Fill activities (i.e., those associated with instream and bridge structures would temporarily displace some species while eliminating others. The design of instream structures would provide suitable habitat for snails and some mussels. The construction of the cofferdams would eliminate shellfish populations and approximately 1,200 feet of the river channel. Those populations existing within the river channel upstream from the main embankment would likely survive within the confines of the reservoir. The littoral zone (shoreline area of the reservoir) would provide suitable habitat for such species as crayfish, snails, and some unionid clams.

(3) Fisheries - Twin Valley Dam would adversely affect downstream fishery resources. The dam would serve as a barrier to upstream migration of such species as northern pike, walleye, and sauger, and at the same time prevent the normal river drift from reaching the downstream area. River drift materials serve as the basic source of forage material for the river inhabitants. This adverse impact would be reduced by placement of instream structures designed to provide holding areas for fish and would allow the development of forage material (i.e., algae, plankton, insect larvae, etc.). Fish trapped within the reservoir would either adapt to their new environment or be eliminated. The reservoir should provide suitable habitat (primarily within the littoral zone) for an abundant and diversified lake fishery. Some of the fish species could migrate upstream, temporarily enhancing the fishery value of pools in that area.

(4) Wildlife - The impacts of the proposed reservoir on terrestrial animal resources would be more pronounced than it would be for the aquatic species. Most of the true woodland bird species would be eliminated from the project area, although some species which frequent forest-edge or water-edge habitat should increase. Some "stream-side" species would be partially or entirely eliminated. Aquatic bird populations should increase in the area, due to the availability of more suitable habitat. The principal game species affected by the proposed project would be the ruffed grouse and white-tailed deer. Elimination of the valley habitat would force deer and grouse populations to migrate into adjacent upland areas, adversely affecting existing populations in those areas as they compete for available food and cover. In addition, the deer population which utilizes the river valley quite extensively during the winter months would be forced to winter in other, possibly less protected, areas. Smaller vertebrates, including some of the smaller species of amphibians, reptiles, and mammals, may be caught on temporary high levels within the pool and would be eliminated as these areas become inundated. Some of these species may repopulate the floodpool area after each intermittent inundation. Management of project-related lands would significantly improve the area for terrestrial and avian habitation.

(5) Recreation activities - Upstream from Twin Valley, the Wild Rice River is an under-utilized recreational resource due to its ruggedness and limited access. However, some hiking, camping, river canoeing, and fishing does occur in the area. River fishing is most often accomplished during the annual upstream migration of northern pike, walleye, and sauger in the spring of the year. Some motorcycling occurs on the north valley embankment, but not to a large extent. Development of Twin Valley Dam and Reservoir would eliminate most of these recreational activities. This would be offset, somewhat, by the proposed recreational development included in the project. Section 6.c.(8) of this evaluation has previously defined these activities.

(6) Threatened and endangered species - Not applicable: the proposed fill and construction activities in the Wild Rice River upstream from Twin Valley, Minnesota, would not have an adverse effect on any threatened or endangered species.

(7) Benthic life - The proposed project and fill activities would have beneficial as well as adverse impacts on benthic life forms. Most fill activities would cause the dispersal of benthic communities while construction of the cofferdams would permanently displace those communities existing within a 1,200-foot reach of the river channel. Recolonization is expected to occur after construction is completed. Riverine benthic communities entrapped within the reservoir would gradually be replaced by individuals more characteristic of a reservoir-type environment. The shoreline (littoral) zone within the reservoir would provide suitable habitat for a large diversity of benthic life forms.

(8) Wetlands - Not applicable: wetlands within the Twin Valley area would not be affected by the proposed project and its associated fill activities.

(9) Submersed vegetation - Submersed vegetation within the Wild Rice River Basin is quite limited. Most vegetative forms are found in tributary areas where they occur irregularly. Thus, construction and fill activities associated with the proposed project would not have a significant impact on submersed vegetation. Once the reservoir has been filled and the littoral zone begins to develop, the relative abundance and diversity of rooted aquatic vegetation should be quite extensive. Primary species expected to become established are pondweeds, cattails, bulrush, and water lilies.

(10) Size of disposal sites - Fill material would be placed in four general areas within the Wild Rice River upstream from Twin Valley, Minnesota: the main embankment, including the cofferdams; two road raises; and instream structures downstream of the dam. The size of these fill sites were designed to have a minimum of impact on the environment but yet provide for an engineeringly sound project.

(11) Coastal zone management programs (40 CFR 230.3 (e)) - Not applicable; fill activities would not conflict with coastal zone management activities.

e. Consideration to minimize harmful effects (40 CFR 230.5 (c) (1-7))

(1) Water quality criteria - Construction and fill activities would not add harmful constituents to the overlying water column; however, an increase in turbidity and temperature and a slight decrease in oxygen levels can be expected to occur. In order to reduce turbidity levels, construction activities would be accomplished during low-flow periods. These variations in the aquatic environment are not expected to deviate from normal river conditions and as a result should not cause a violation of the Minnesota Pollution Control Agency (MPCA) guidelines for a class 2B stream. A water quality analysis has been performed by the U.S. Army Corps of Engineers, Waterways Experiment Station (WES) in Vicksburg, Mississippi, for Twin Valley Lake. Results of this analysis indicate that the reservoir would become quite eutrophic and that brief periods of anaerobic conditions can be expected to occur. In order to reduce the initial degradation of the reservoir's aquatic environment, WES has recommended that a series of flushings be performed on the reservoir prior to its final filling. A multi-level outlet structure placed in the main embankment would help reduce the degrading effect that out-flows may have on the downstream environment. Thus, the temperature and chemical properties of the reservoir and its corresponding outflows are not expected to exceed the guidelines established by MPCA.

(2) Investigate alternatives to open water disposal - Not applicable: the proposed project does not require use of open water disposal areas.

(3) Investigate physical characteristics of alternative disposal sites - Initial investigations for the location of a flood control dam on the Wild Rice River indicated that two potential sites existed upstream from Twin Valley, Minnesota. The authorized site is located approximately 2.5 miles upstream from Twin Valley, while the alternate site is located about 1 mile further upstream. The recommended plan presently calls for the construction and development of a dam and lake at the alternate site. Both sites are identical for all practical purposes and would have similar environmental, aesthetic, economic, and recreational impacts while providing similar flood control protection.

(4) Ocean dumping - Not applicable: fill material would not be placed within a marine environment.

(5) Where possible, investigate covering contaminated dredged material with cleaner material - Not applicable: clean fill material would be placed over the existing river channel and river valley substrate.

(6) Investigate methods to minimize effect of runoff from confined areas on the aquatic environment - Not applicable: fill material would be placed within or across the existing river channel. No confined areas would be utilized during project construction.

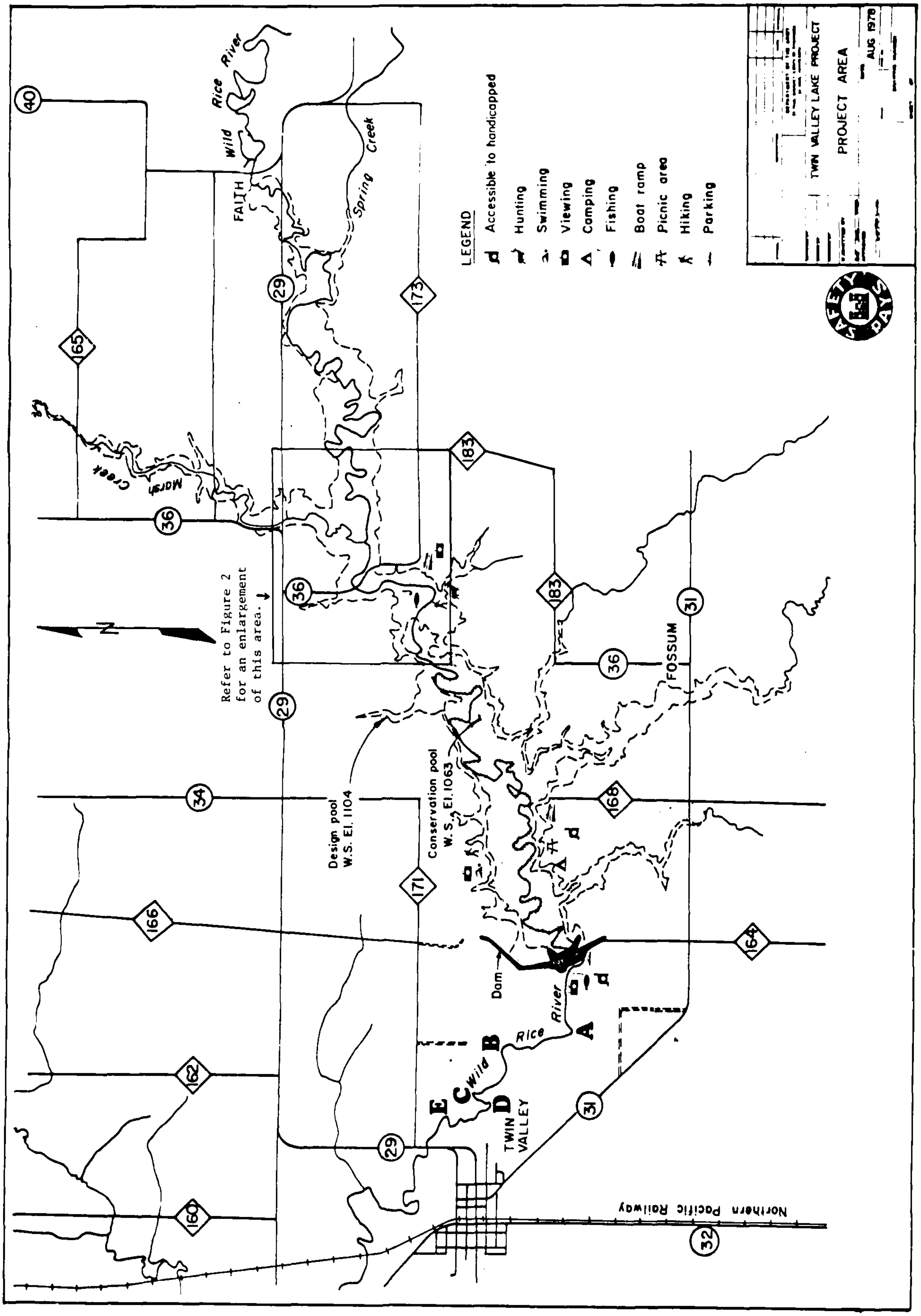
(7) Coordinate potential monitoring activities at disposal site with EPA - Water quality monitoring (conducted in conjunction with the Environmental Protection Agency) of fill activities at the proposed project site is not presently planned. However, a water quality analysis has been performed for existing conditions and extrapolations made on the water quality for Twin Valley Lake. The results of this analysis are included in this Supplement to the Final Environmental Impact Statement (dated February 1975).

7. STATEMENT AS TO CONTAMINATION OF FILL MATERIAL IF FROM A LAND SOURCE (40 CFR 230.5 (d))

Fill and riprap materials needed for construction activities associated with the proposed project would be obtained from excavation activities associated with the formation of the main embankment and its structures, two borrow sites located south of the left abutment, and from one of the numerous sources of quarried rock and fieldstone within the Twin Valley area. All surface materials not directly utilized as fill material would be removed and stored for later use. Soils within the Twin Valley area consist of lacustrine and alluvial sediments underlaid by glacial drift material of dense till with associated beds of clay, silt, and sand. These materials are of glacial origin and would not add chemical constituents that would be harmful to the aquatic environment.

8. DETERMINE MIXING ZONE

Fill material would not add harmful constituents to the aquatic environment. The river valley substrate, however, contains large quantities of organic material which would be added to the aquatic environment following inundation. Thus, it is expected that nutrient enrichment and anaerobic conditions would exist within the hypolimnion of Twin Valley Lake, due to the extent of organic decomposition that would be occurring within the benthic zone. These nutrients would then be added to the upper layers of the reservoir during seasonal and wind-generated mixing periods. Releases of bottom water to the downstream area would appreciably degrade water quality due to low oxygen and high nutrient levels. Multi-level releases would lessen this impact to some degree.



LEGEND
Accessible to handicapped
Hunting
Swimming
Viewing
Camping
Fishing
Boat ramp
Picnic area
Hiking
Parking
TWIN VALLEY LAKE PROJECT
PROJECT AREA
AUG 1978
SAFETY PAYS
Refer to Figure 2 for an enlargement of this area.
Design pool W.S. El. 1104
Conservation pool W.S. El. 1063
Dam
Wild Rice River
Spring Creek
Marsh Creek
FAITH
FOSSUM
TWIN VALLEY
Northern Pacific Railway
N
A
B
C
D
E

FIGURE 1

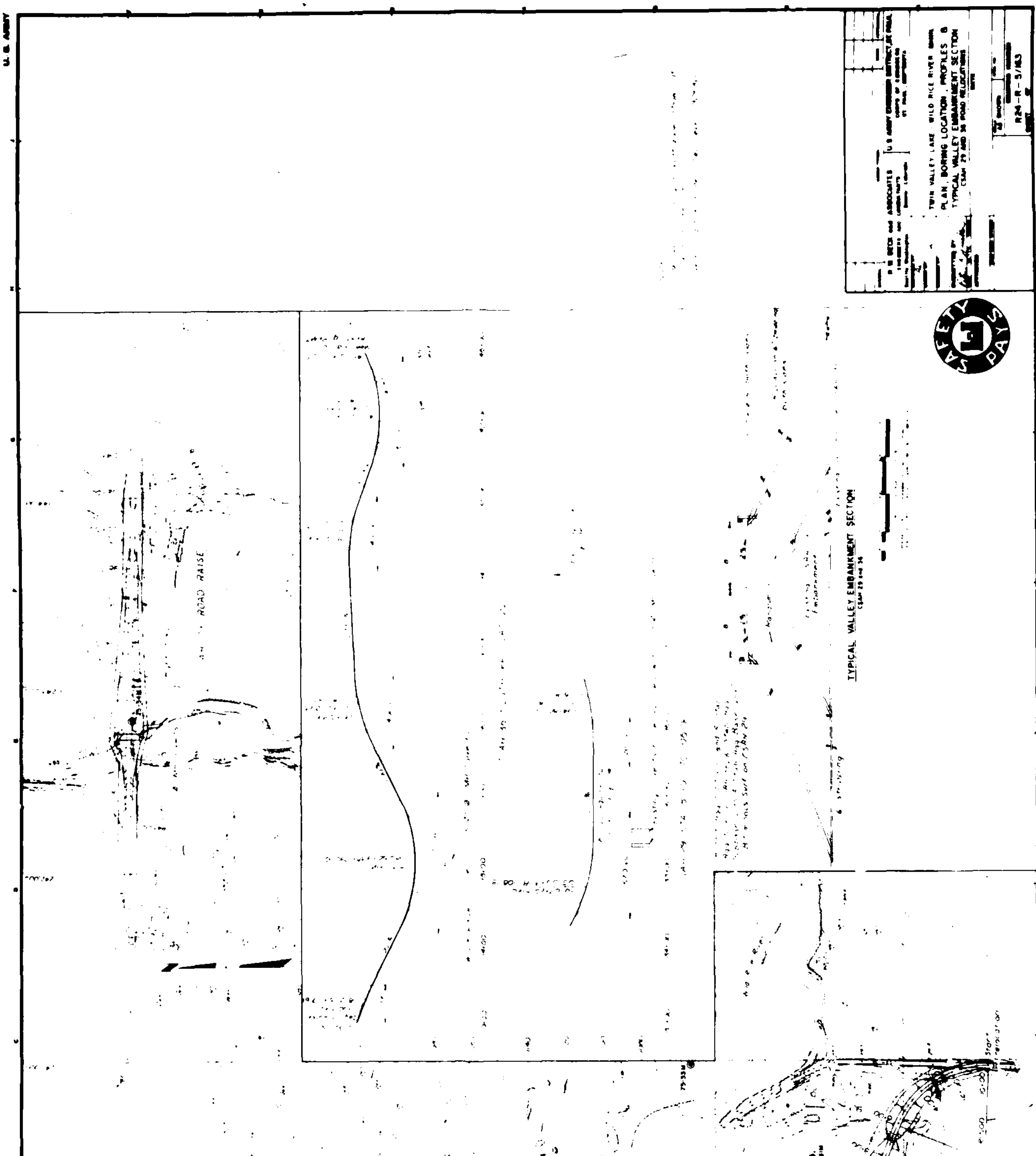
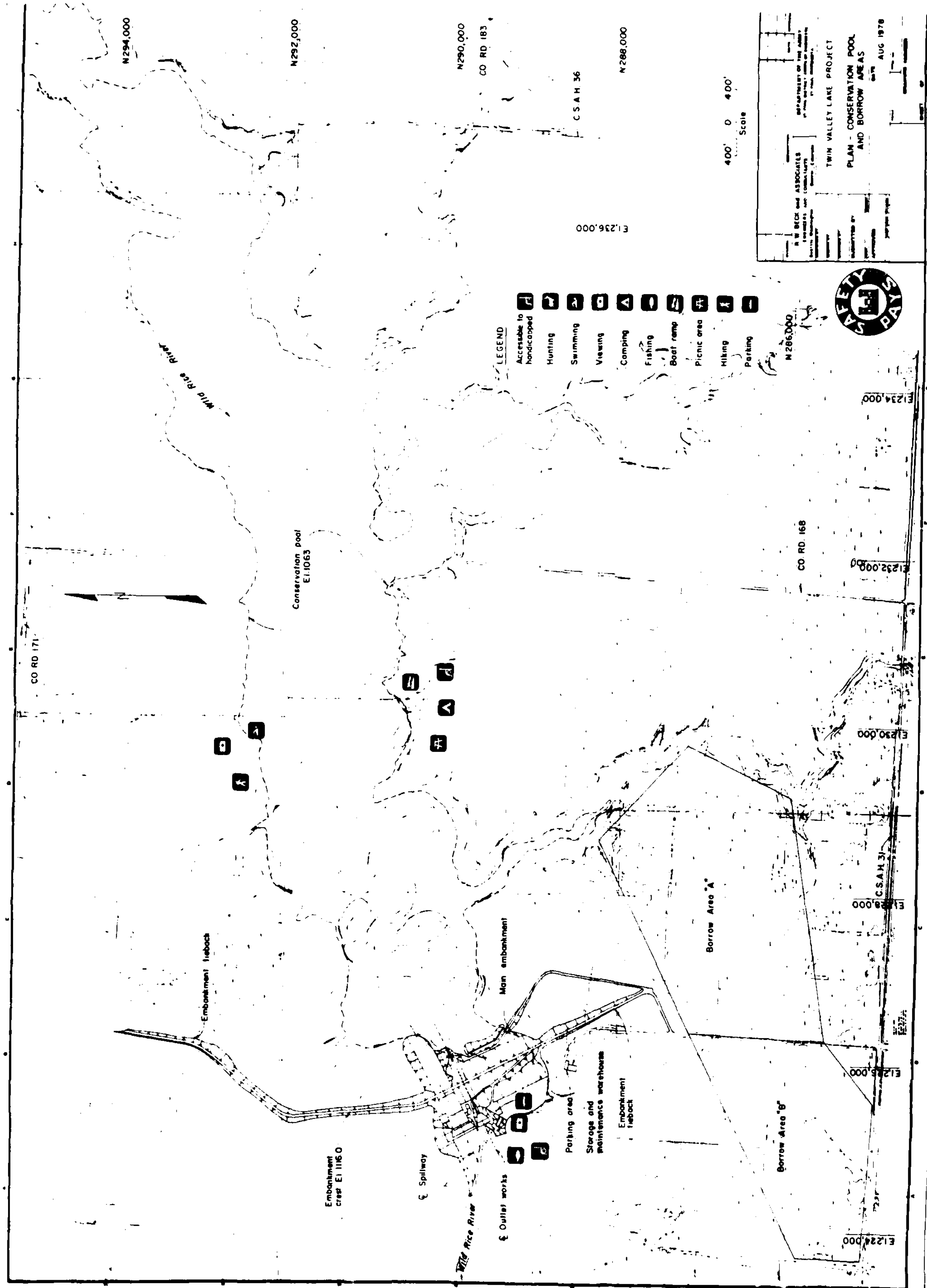

U. S. ARMY
CORPS OF ENGINEERS
TYPICAL VALLEY EMBANKMENT SECTION
SAFETY PAYS

FIGURE 2



TWIN VALLEY LAKE PROJECT
PLAN - CONSERVATION POOL AND BORROW AREAS
AUG 1978
R W BECK and ASSOCIATES
400' 0 400'
Scale
LEGEND
Accessible to handicapped
Hunting
Swimming
Viewing
Camping
Fishing
Boat ramp
Picnic area
Hiking
Parking
SAFETY PAYS
N294,000
N292,000
N290,000
N288,000
N286,000
E1,236,000
E1,234,000
E1,232,000
E1,230,000
E1,228,000
E1,226,000
E1,224,000
CO RD 183
C.S.A.H. 36
CO RD 171
CO RD 168
C.S.A.H. 31
Wild Rice River
Conservation pool El.1063
Embankment tieback
Main embankment
Borrow Area "A"
Borrow Area "B"
Embankment crest El 1116.0
Spillway
Outlet works
Parking area
Storage and maintenance warehouse
Embankment tieback
Wild Rice River

FIGURE 3

END
FILMED
4-84
DTIC